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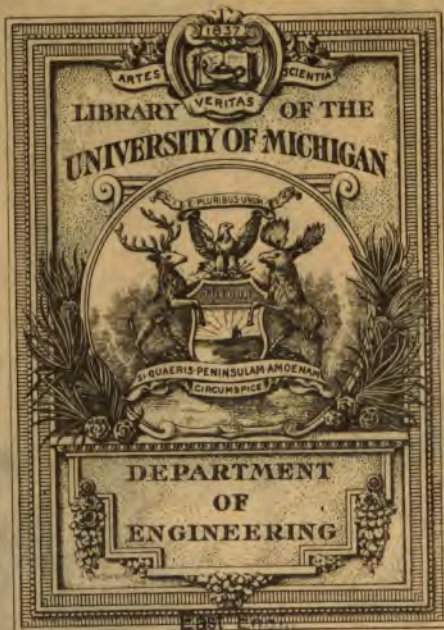
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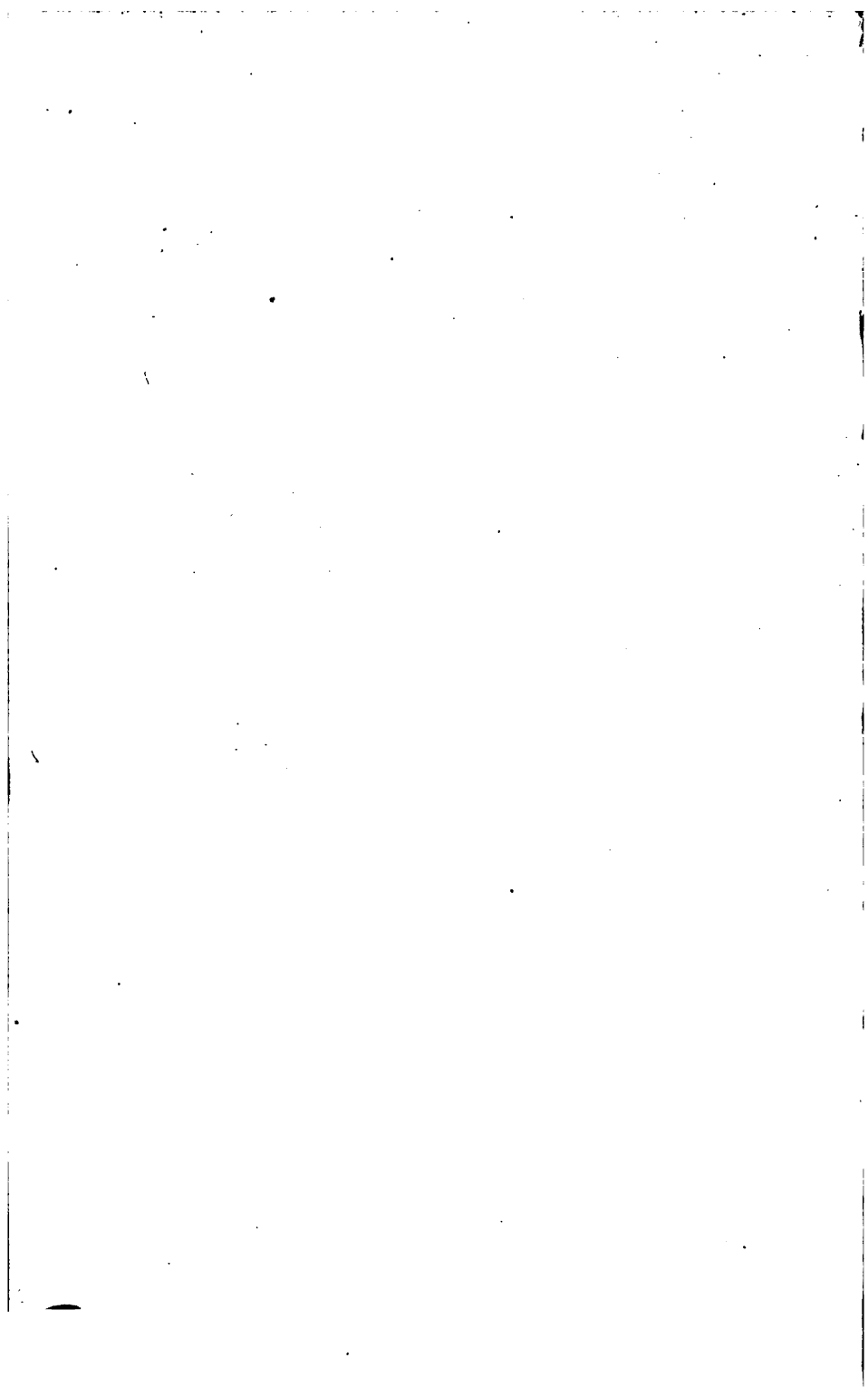
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HARTNESS FLAT TURRET LATHE MANUAL



Hartness, Jones

A HAND BOOK FOR OPERATORS



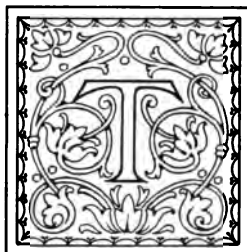
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HIS Manual of the Flat Turret Lathe is intended to aid the Flat Turret Lathe operators in acquiring a true understanding of the machine.

Since the machine is only an implement it cannot be considered as a thing entirely apart from the man.

In fact the man is the greater part. The personal welfare of the operator must be considered. This is something more than the man's relation to the machine. It includes an equally important phase—his relation to other men and to his environment in general.

Progress of the individual in the machine shop is dependent not only on his skill and his knowledge of machinery; it requires a fair comprehension of the general personal environment. This means that each man should have a good understanding of his fellow-men. This knowledge comes slowly because there are so many facts that are never mentioned—the older heads may know much about them—all close observers may acquire a fair degree in time, not so much by what they actually see as by inference drawn from observed actions and development in shop life.

To disregard the personal interests of the operator would be to miss the principal element in the consideration of the use of the machine.

We cannot fully know our fellow-creatures. There are always barriers between man and man. We do not know all that is going through a man's mind when we are

talking to him. We cannot tell what motives are the real mainspring to his actions. There seems to be an impassable barrier between the frankest of men.

This phase of human life becomes most marked between men who are in competition with each other. The competitive side of life in the machine shop is not fully understood by the new man and frequently the old-timer has a wrong notion regarding it.

The human side of the problem of the Flat Turret Lathe is given the first place in order to approach the subject with right attitude.

The mechanical problems are getting more and more complex, but still the greatest problem for each man is, how to understand his fellow creatures. No attempt will be made to give the last word on this subject, in fact little more than an inkling can be offered. But this inkling may establish a line of thought that will accomplish great things for each one who allows it to actually get into his mind.



TRADES ARE CHANGING



WE have heard so much about the world's progress that we have become more or less indifferent to statements that would otherwise cause us to stop and think. Just now, however, we not only have these stories, but each individual is beginning to feel the effects of the new conditions.

The earning capacity of each trade, profession, and of invested money, has not only been changed, but it is continually shifting. Some find the present conditions worse than the old, and others find the new conditions very much better.

The progress has greatly changed the methods of working metals.

So great has been this change that it is difficult to determine the boundaries of the various trades. We do not know how to describe the machinist trade. We know what the machinist trade was twenty years ago. Then, a journeyman machinist was a man who could "run" any machine found in the general machine shop, viz., the lathe, planer, shaper, milling machine, etc. Then, every good "all around" machinist knew all about all of the machine tools that were in general use. In fact by going back two or three score years, we come to a time when a good "all around" machinist knew all about all machines used in cutting metals.

A machinist of those days was skillful in the use of hammer and chisel and file. In fact he possessed a skill in use of these and other hand tools that is very rare to-day. The present scheme shapes metal to satisfactory finish by machinery so that there is less demand for the skillful hand workers. A good hand at chipping and filing has very little chance to show his skill and consequently he must be rated according to his usefulness in the present methods.

In the machine building plant of to-day, about one-half of the men are in charge of machines; the other half have various duties incident to the work of fitting, assembling and handling the work. The tendency is to eliminate the hand fitting by use of machines of greater precision than those of former times.

There may be a growing demand for machinists who are adepts at chipping, but if there is such a growth, it is very small in comparison to the great increase in demand for men to handle the latter-day machinery, and for men skilled in the kind of fitting that is now required in assembling machine parts after they have been machined.

We have reached a time when a man is said to be a valuable workman when he excels at any one of the branches of the art, as for instance if he excels in useful knowledge pertaining to some one machine.

THE MACHINERY BUILDING WORLD IS A PEACEFUL PLACE

In looking over the machinery world we find immense numbers of workers employed at peaceful work. It is a kind of work that has the minimum of strife and personal battle for progress. Not that human nature is different in the machinery world; but since the very nature of the work enables most men to make their headway without injuring or hindering others, the cause for strife is less.

The advance of an individual is frequently accompanied by a general betterment of the whole world. It is not a case where there are just so many opportunities to be dealt out by fate. The extra effort of the individual creates an extra value as truly as a drone takes away from the wealth of the world. Although this may be said of all work, there remains the fact that in the machinery building world the individual is within easier reach of the direct fruits of his endeavor. Of course there is a marked difference in the natural efficiency of the men. One man can operate a certain machine and another can't make it go. One can manage a department or plant and another would be very uncomfortable if he tried to do so; but each can by intelligent endeavor fit himself for the best position for which he is endowed. There is always a good demand for the best of each kind.

A good workman loses his chance for progress if he continues to stick to one class of work after the progress of machinery has taken away the need of his skill. He will be like a fly that is trying to go through a window pane.

The fly buzzing against the window pane would do better to go off in some corner by himself and think the matter over while quietly preening his wings with his hind legs. He would doubtless figure out that there must be an open window or door, or at least a keyhole elsewhere, through which he can make his progress.

There is now a new order of things in the machine shop due in part to the greater volume of work (which has made it possible to specialize) and to the progress in machine design (which has developed machines so intricate that the ordinary brain is incompetent to comprehend more than one or two of them). But whatever may have been the cause which has led up to the

present condition, we must conform to this new state of things. We must not only fit into the world as it is, but we should try to get in line with the drift of things, in order to find a good place in the world to-morrow, next month, or next year.

A careful survey of the conditions will doubtless force upon us the fact that the greatest opportunities lie in the direction of specialization. We may see that there are just as many opportunities for the "all around" machinist of olden time, but there are greater results to be had by specialization.

On all sides the machinist meets men who know more than he does about special machines and if he is wise he will understand that he cannot know all about all machines. There are so many of these so-called special machines that one man cannot know all about all of them.

The change has broadened the requirements beyond the scope of the individual. When we have carefully faced these facts we will see the need of concentrating our work and study in order to fit into the world as it is now.

THE OPPORTUNITIES OF THE MACHINERY WORLD

We are told by some that machinery has taken away the opportunity for the worker to use his brain and get the development that comes from such work. So prevalent has become this notion that a word regarding this phase will not be out of place at this time.

It seems strange that such statements are made in the face of the fact that the world has never seen a time when there was an equal number of good opportunities and positions. These positions call for the best there is in a man. There is now a myriad of workers who have the chance to develop their brains to their limits.

The greater intricacy of the later machinery gives every one a chance to go ahead to the full measure of his mental capacity and energy.

The notion that men have been reduced to mere machines by the introduction of better implements has doubtless grown out of the fact that in the process of evolution of machinery such conditions have temporarily existed. But such conditions have been comparatively rare. The individual cases, lamentable as they are, should not be taken as representing the trend of the affairs of the vast majority of workers. The general trend has been toward an almost infinite betterment of all conditions of life.

Some may contend that the very mental stress of the present work may reduce man to a mental automaton or a calculating machine, a kind of a machine which is good only for one kind of work, and which possesses no reasoning powers.

To give a complete reply would carry us too far adrift from our main topic toward which we are leading, but we cannot pass the point without a word regarding the quality of the development.

The quality of the development will be measured by various standards, according to the taste of the individual, but we can all agree on some of the essential points for gauging.

We shall not try it from the poet's standpoint but even that side takes no second place if Kipling's view is right as set forth in "McAndrews' Hymn."

We shall only try to see if the present scheme of things in our particular line produces a good average of mental and bodily conditions—a life that is comfortable and desirable—a kind that compares well with other schemes of life.

The progress of machinery carries with it the progress of mankind, but in so doing there are cases

where there is a temporary hitch in the individual progress.

When the method or machinery for accomplishing a given result has been so changed that an unskillful workman can take the place of a good workman, then, in the natural order of things there should also be some corresponding change by which the displaced workman may also progress. Surely this is the general trend of the times. The few examples of displacement without other opportunity should not be taken as representative of the whole scheme.

The period of mal-adjustment can be materially shortened by an effort on the part of the worker to get in line with the new conditions. Just what constitutes the best effort for each one cannot be stated in general terms, but taking into consideration the trend of the times, the opportunities afforded and the object for which one is working, a chance will be seen for each to select some course that will be infinitely better than the one into which an indifferent man may drift.

Nearly all men have some ambition to acquire a trade, to progress in a trade already acquired, or to learn the "ins" and "outs" of the shop practice in order to fit themselves for some one of the various positions in connection with either the manufacturing or the business side of the machinery business; but whatever may be the ultimate goal, each one requires some knowledge of the shop work and shop life in order to qualify for any one of the many positions in connection with the machinery business. In acquiring this experience care should be taken to get in the line of the most progressive methods.

The old methods are passing out and a very complete knowledge of former practice should be considered only as a stepping stone to a better comprehension of the present and future methods.

Many of the best opportunities lie in the line of a narrow range of work. A man who is the best workman or the best informed man on a certain class of work invariably has the best opportunities. To become the highest authority on any specialty requires concentration of effort. The work must be in that line and the mind must be kept there. The same is true if one aspires to become a workman of high standard, either from point of precision of workmanship or of great ability to get the most out of a machine or a roomful of them. The acquisition of an ability to get out work in large quantity from a given machine is the natural road to acquiring an ability to get the best results in the management of an entire plant. But whether it is the workman with large experience or the new man just entering the works for any one of the many objects, the efforts should be concentrated towards acquiring a knowledge of the latter-day practice.

The concentration should not be of the kind that refuses to carry a watch without first counting its wheels and studying its construction in detail. There are many things like the watch that we should use without loss of mental energy over contemplating the details of its mechanism. Many of the latter-day machine tools contain features with which we need not concern ourselves. Each man should be willing to let some of the great mass of mechanisms continue to operate without his attention. On the other hand, there are some facts that must be culled out of the vast storehouse of printed and known matter, that must be fully known and appreciated. For instance, we have data galore of proper speeds and feeds for cutting tools of given quality and shape, for a given kind of lathe, but after all there are a few kernels of facts which, once possessed, save a lot of time and mental energy. Anyone can understand the real necessary facts regarding speeds and feeds. It takes no great knowledge

of mathematics to know how to set the speeds and feeds for a turret lathe; nevertheless, very few men seem to know what feeds and speeds to use. Later on we shall try to set forth some of the controlling facts separated from the vast amount of matter in which they are usually embedded. But no attempt will be made to go into the needless description of a thousand and one features of the work, for such things may be neglected just as we disregard the construction of the watch.

Such facts carefully digested become a reliable basis on which to determine speeds and feeds for turret lathe steel work. In like manner a general statement regarding the use of various features of the turret lathe will enable one to know what product may be expected from such machines and how it may be produced. But before considering mechanism it is necessary to consider the man. Not the man as an animal, but the real man, which we get at in studying the motive, the aim, the disposition, the purpose and the human side. All the knowledge of the mechanism will be useless to anyone who does not have the true view of machine shop life and its personal problems.

THE PERSONAL SIDE.

Loyalty to fellow-workmen has, in some instances, been perverted to a spirit that is contrary to an energetic interest in producing a good quantity of output. It sometimes produces the feeling that anything that makes a machine turn out a large quantity of work, is against the general interest of the fellow-workers.

We all worship loyalty of man to man and are even ready to excuse almost any injury if it is due to a good motive of this kind. But we also like to see a man intelligently loyal. For it is intelligent loyalty that obtains the best results. Loyalty to one's own family as well as to fellow-man and to self, all demand the same

line of action. When this is clearly seen a fairly easy course may be plotted.

Sometimes there is felt a spirit that tends to retard the work, to discourage pushing for good quantity of output. It is not often mentioned but it is frequently felt that the strenuous life is not in "good form" and is not fair to the other workers. Occasionally a man is advised not to "kill a job." The man who makes such a request is generally a good fellow, one liked by every one, but he is not generally a good adviser. His view is not the whole view and his intention to "set you right" is born of a good purpose but not of complete knowledge of what constitutes the most comfortable and at the same time the most progressive scheme of existence. He is unquestionably right under certain task masters who make the whole aim to drive, drive, drive, regardless of what might comfortably accomplish the same results by better or other methods. But in the average works, in which the latterday implements are employed, there is generally no good purpose served by holding down the output. On the other hand, the progress of the individual, in his advance and in his comfort of existence and respect of his fellow-men, comes from getting the best results out of each implement.

Any man who has been up against the real conditions in the works, knows that there are two sides to the question of hustling. The side favorable to a moderate gait is brought out when we have been appealed to by some one who has previously been doing the work under consideration. What is a man to do who undertakes a new work and is approached in the following manner by a fellow who has been on that work for a long time? "Say, don't kill that job, I have been doing that work for some time and it is a hard job when run at a rate that turns out four or five pieces per hour." "Yes, the machine will do two or three times that number, but

pushing the machine will 'queer' you with the boys. If you are loyal to us you will hold that machine down to not more than five per hour."

We do not see such talk in print. We do not hear it very often, but we know the spirit, and let it be said right here that the pen cannot pass over this phase without expressing praise for the man who does what he thinks is for the good of others, especially when it is not to his own advantage.

Commendation is due regardless of whether the good is really done or not. It is praise for the altruistic motive. It is the same quality that leads men to war, to various kinds of martyrdom, from the days of torturing of religious martyrs to the present day, when men must be either martyrs or cuckoos. It is more comfortable to be a cuckoo; to always endorse the medium popular views on all subjects. But some men are so constituted that they must speak out as they feel, particularly if it seems to involve a sacrifice of this or that one's esteem. The man who goes contrary to the medium view is generally partly wrong, but he must be given credit for having used his brain and lived according to his view. His view may have been only a half view, wholly one-sided, but his conclusions may have been true to his sight. The same man with the whole view might find reasons for endorsing the popular notions, but if he did endorse he would do so not because they were popular but because they seemed right to him. Nearly every man holding extreme views on any subject will be found at heart all right, if we have a chance to understand his reasons for his position. He becomes a queer one the minute he utters an opinion that does not fit the views of his environment. We admire the martyr in either case, whether he is right or wrong. He has the credit of having given thought to the matter and acted on his convictions. But notwithstanding our admiration for the fellow who acts according to

his light, we find that it is one of the most unfortunate conditions when such an one has not had the benefit of the full view of the situation. For this man, with a correct view, could be depended upon for great things for himself and others.

The object of this chapter is to set forth some of the reasons for striking a different gait—not a harder one—but a more progressive and actually an easier scheme, one consistent with true sense of loyalty to fellow-man and one that will “prove out.”

We shall not regard the interest of the “Company,” excepting as it furnishes a good means of livelihood and advancement, but we shall show that loyalty to one’s own family, to his fellow-workmen, and to himself, should induce a keen interest in the output of the work.

We shall not say that the “Don’t kill the job” was said by a man who seeks favor in the foreman’s eyes, by the resulting comparison of work produced by him and you. We shall not say that such talk comes in any way excepting with the intention to help you, but regardless of the motive it is absolutely bad. It is exactly the advice that would be used by the very Evil One if he worked in the machine shop and desired to hold back the progress of each man. Let us now see the result of taking an interest in the game.

More than one-third of the day is spent in the works and it averages to be more than one-half of our conscious hours, or in other words, more than one-half of our life when awake. If we disregard the advancement made possible by industrious attention, and if we only consider our daily comfort during the hours spent in the works, we shall find that a keen interest in the game of work is desirable, for it cuts out the pain and discomfiture of clock watching. It also results in our learning many facts that would never have been known if we should only strike a pole-horse gait.

Nearly all of the modern tools may be pushed to an interesting limit. Some of these machines are "man killers" and such machines should be operated only by the man who needs plenty of exercise, but the majority of machines may be pushed to their limit without increasing the energy put forth in the day beyond the point that is more than offset by the return that is obtained in the interest in the work.

When you contribute to the spirit of "get there" in a plant, you transform it from the disgruntled condition, which is usual where there is no interest in the work. By this scheme of pushing things, men are rapidly advanced from position to position, even if the plant itself does not offer more than a meager number of positions, for the progress takes each man along to the best paying work of which he is capable, and when he has reached his limit within the plant, there is a constant demand for the interested man outside.

Shifting from place to place is bad, but it must be done in some cases to allow the natural progress of men in the works. If all the best positions are filled by men that never move out there is little opportunity for others. When there is no chance for progress there is a tendency to lapse into an indifferent mental condition. And this is disastrous alike for the workers and the employers.

Loyalty to all concerned makes it right for each man to make the most of himself, to get the most out of each machine he may operate and to let others know that there is a more comfortable existence than clock watching, and that holding back the output is actually against every man's welfare.

It goes without saying that our progress in the works improves the conditions under which we spend the other half of our conscious life.

A gain in earning power would not be much of a gain if it were not accompanied by a scheme of life that

made that power an advantage to a more enjoyable or more comfortable existence.

Some find their habits are too much for them to control within the bounds of what is considered respectable by their family and neighbors, and others find the mind tends towards useless wandering that builds air castles or imagines grudges, slights and personal enmity. All such conditions are favorably affected by an absorbing interest in the work. This interest leads to reading technical journals. Those journals like the "American Machinist" and "Machinery" both published in New York, become intensely interesting.

If a mathematician tells you that he can get the same thrill at the solution of a problem, that can be experienced at the climax of an opera, you are disposed to say that he is not normal and that there is no use of your trying to get pleasure out of work or mathematics or technical journals; but do not settle this question until you have tried it. You will not find any new subject thrilling—you must develop your interest—it will grow if you will force your attention back to the subject every time you catch your mind wandering, and you will acquire the keen interest and the pleasure of the hours in the works, and the opportunity to read on the subject in the evening.

Your interest in your fellow-man will be shown by your readiness to set him right and you will have no suspicion that your loyalty to him is only a blanket for your own indolence.

If indolence were more comfortable than industry it should be indulged in, but if it is really an uncomfortable existence then it should not be tolerated.

There may be a few men on earth who are more comfortable in a happy-go-lucky indolence but there are thousands who would have a better time in this world if some one would "put them right" on this subject.

There is no reason for disturbing the man who is comfortable in his indifference, but this is to point out an easy scheme of progress, one that gives more comfort and real satisfactory pleasure than nearly all the other schemes of life.

To the man who has fitted into a good permanent position, which seems sure to last as long as he lives and which is fairly satisfactory,—there should be no disturbing note—he should not be disturbed by talk of greater things. Anyone who has found a fairly satisfactory work, should not throw it away by scrambling after some rainbow pot of gold.

The first twenty or thirty years of shop experience should be the progressive years; after that the fruits of experience should be enjoyed by a comparatively peaceful following of the work as it develops. But at all times each one should keep up to date by close observation of new development.

Many a man with a good position has been led to discontent and loss of position by impractical preaching of ambition and enterprise. A good reliable comfortable position should not be given up without some fairly definite knowledge of what is to be gained by the risk. If all is true that has been written on the subject of advancement as the result of study, we all can fit into the greatest positions in the country simply by studying. But we know well enough that the requirements of some of the greater positions would make us decidedly ill at ease and that we should be entirely out of place in them.

The fact that each man is endowed for a certain kind of work, should be taken into consideration in trying to determine which way to try to travel. A dissatisfaction with present employment should not be taken as evidence that a change should be made, for discontent is inborn in some of us, and if it is not there by nature, we

know we are all susceptible to a disturbing preaching. Almost any contented man will be changed over by just a few words whispered in his ear. The statement may be false, but if it is believed it will be effective just the same. This thing takes place without any real change in the conditions, therefore it illustrates that the discontent may be due to a false view.

If we see ourselves caricatured in advertisements, it tends to discontent. Such caricatures should only arouse our disregard for the utterance of the man that will issue such libel, but unfortunately it does not usually operate that way. It frequently creates discontent, therefore discontent in itself should not be considered as a proof that a change should be made. The only real indication that a change should be made is a clear view of a better opportunity or position, and a true knowledge of the trend of the times.

Before taking up the subject of the turret lathe, let us glance at the tendency of the times, in order to determine the way the art is drifting. We know that this is a machinery age, one in which each succeeding year seems to out-do all others. We know that there are indications on every hand that machinery will be made and used more and more as years go on. We know without looking for statistics on the subject that there is infinitely more machine work now than ever before, and we have good reason to believe the greatest number of good opportunities for individual progress must be in this most active work.

There are other fields of good promise, but none excel the machinery building world in good opportunities for the individual. Therefore, it seems safe to conclude that the machine building world is a good place for us to live and put forth our endeavor.

The next thing to decide is what part of the work holds the largest promise. The field of invention is

surely good and the demand for all kinds of able men is good, but whether the endeavor is to be toward invention or any of the various positions in the mechanical or the business side, the preparatory course should be one that puts a man in close contact with the real methods and conditions under which work is produced.

Swimming should be learned in the water, not by a correspondence course, and a true sense and understanding of shop work can best be obtained by real experience in the work. Books may tell us how to work, but we must get the further knowledge from the practice.

DIGNITY OF WORK

The progress of each individual is of greatest importance, but let us get over the notion that the greatest positions are those of authority over other men. There are many such positions which keep down the best there is in a man. A position of authority is frequently one of most exacting servitude. It is seldom a comfortable position. Each one should strive to succeed in his own particular way and his own natural work. It is not true that all men have an equal fitness for this or that position. Some men are built for doing things, others for directing, recording, accounting, and in various ways co-operating with the real workers. Some are born inventors and others work out their greatest possibilities in constructing. Some are endowed for mathematics or finance or mechanics, and in various other ways individuals differ in fitness for the various positions.

To preach that it is dishonorable to work with the hands, and that dignity goes only with the position in which the pencil is used instead of the implements that change the form of things; that positions of authority are the best—all such talk is contemptible stuff. To say that the worker is the under-dog, that he is ever envious

of and oppressed by the man who directs the work — all this is a malicious libel that should be struck out of existence by a more general knowledge of the real facts. To say that a man, who can and will enter the turret of a battleship and perform any one of the several duties there, is less than any man who could not and would not do so, is a mean lie. If our minds were not perverted by these popular notions, we should see things in their true light. To say that men who are capable to disentangle a wrecked telephone switchboard or to put right any one of the thousand complicated mechanisms now in use in the general industrial world, are less than others who cannot do such things is another false notion, and last but not least, to in any way belittle the worker is nothing less than criminal. There are men who are born to work with their hands—they are happiest in their natural element—and any one who caricatures them for political or commercial reason, to put it mildly is not their friend.

In order to catch the full significance of the popular notions regarding dignity of various callings, it is only necessary to get a close view of some of the lives of men who have been disturbed by some of the prevalent notions.

Ambition is good, but it should not be preached in a way that disturbs or drives a man out of his best place in the work. The health and perhaps the very life of the man who longs for a position at a desk may be dependent on his getting the exercise which his present life gives him.

Everyone should try to get into work of the kind that will bring the best results in health and happiness for himself and family.

If the false ambition microbe has so swarmed in his being as a result of a misunderstanding, it usually causes much discomfiture for all concerned.

REAL PROGRESS IS CONTINGENT
ON KNOWLEDGE OF MEN AS
WELL AS MECHANISM

Progress of the individual is based on technical and business knowledge, but it also requires an understanding of men. The degree of progress is largely dependent on these three points. The individual should possess the best knowledge of his fellow-creatures, whether they are the managers or the newcomers in the work — whether they are higher or lower in authority in the organization.

An experience with the men who “do things” gives a man a truer conception of the dignity of work and a better understanding of his fellow-man. It may not be necessary to know such facts. We see people all around us who are getting through the world with no true understanding of their fellow-creatures; but, other conditions being equal, the degree of progress and comfort in this world comes directly in proportion to the degree of our true inner knowledge of others.

There is not one quarrel in fifty that is not born of a misunderstanding. This proportion fits also a thousand other nerve wearing incidents that are so extremely fatiguing to mind and body. Nearly every one knows that many of the times when he has been extremely irritated by some one, it was due to a misunderstanding of either one or both. So commonly have we used the term misunderstanding that it has lost its full meaning, or if it has not lost its meaning to us, it has certainly failed to make the full impression when used.

A good knowledge of our fellow-men is the real basis of a comfortable existence. Some people classify all others in the most careless manner. They have a very few standards of measure. If it relates to measuring another's mental capacity, the victim must be a cuckoo

to all of the popular notions and must not be a pioneer to any of the sciences, at least he must make good against great opposition if he dares to venture beyond the orthodox notions of the conservative schools of each science. If they are estimating the notions and general characteristics of the workers, it is frequently on a standard made up from notions gathered from people who do not know these men.

To those of us who have literally "been through the mill," there is an admiration for our fellow-men that takes in nearly every individual on the face of the globe. If it is not quite as broad as Walt Whitman's, it is at least a long distance removed from the false notions that picture workmen as an inferior race of men.

Perhaps all of this may seem very far afield from the subject, but there is no subject that is separable from man. It is always his mind that contemplates the subject, and the subject frequently includes the minds and general characteristics of others.

We have had so much said regarding the height of cutting tool above the center and the proportions of gears for screw cutting and similar very necessary details, that there has been no time to "set our fellow-men right" on some of the questions which are equally necessary. We shall finally reach the subject proper, but let us reach it with a true view.

AMBITION

To be ambitious to attain the unattainable only causes needless discomfiture.

If a man is sure he is in the wrong place in the world and that there is another place in which he can succeed, then it may be well for him to run the risk incident to the change of giving up one position and jumping for another. Most men are so loaded with responsibility to others that they cannot run any such risk. Changing from one kind of work to another is usually accompanied with a reduc-

tion in wages or salary. The new position may look favorable from the outside, but it may not be so good when actually tested. Any desire to change should be carefully considered.

The extreme case of the prodigies for music, mathematics, invention, or any other profession or work, are so rare that they may be safely disregarded in considering the basis of a desire to change. The average man longs to progress. The longing is not evidence of qualification, it is just an ache. With this ache there should be a keen sight of the real facts from a disinterested standpoint, but that of course is impossible. The individual self-interest not only constitutes an obscuring medium but sometimes it plays the tricky part of the mirage which so woefully deceives. If the natural desire cannot be trusted, how is a man to know which way to move? The natural inclination perhaps would be the most reliable indication, if it were not the result of a misleading group of ideals that are so prevalent today. It is natural for us to follow the inclination of our minds but unfortunately the mind absorbs false notions just as readily as true ones. If our friends say that this calling is respectable and that is degrading, and if we have heard such talk from all sides ever since we began to take notice of things on this earth; if the men following a certain line of work have been so affected that they pass their entire existence under the impression that their work is not respectable; if they are aided in such notions by others in other callings; is there any wonder that we get false notions and that these induce false ambitions?

Disregarding the few prodigies on the face of this planet, it is safe to say that the way to progress is to convert the superfluous ambition into work. Keep ambitions, but always industriously study all about the work in hand and as much about the work that is just ahead as the opportunity affords.

This may be considered the essence of the whole plan for greatest progress with least hazard.

A studious habit of mind may be acquired by any normal mind.

Many connect study solely with books with no thought of the kind of study that is meant here. The thoughtful, careful consideration of each phase of work, while at work and in moments of rest, is the real kind of study that is the most needful and efficient. After this, the books mean something, and without this the contents of books are of little or no value. Storing the mind with undigested data may be good for passing examinations and even useful in certain lines of work, but swimming must be learned in the water. To excel as a swimmer the book becomes a help, but don't jump into deep water until you have had something more than a correspondence school course in swimming. This is not intended as a slur on the correspondence schools, for most of them are doing a great work, although they have in some instances caused men to become discontented with the very positions for which they are naturally endowed and have induced some to pay out hard-earned money for something that they were not built to take in.

The best scheme then for the progress of the individual is to get interested in both the work in hand and that just ahead in the line of progress.

TRADE SECRETS. ASSISTING OTHERS. THE MEMORY FIXING SECRET.

Next to the subject of personal interest in the work in hand there should be considered the disposition towards others in the same work.

There can be no doubt that an interest in the work relieves the pain and fatigue of clock watching and perpetual uncertainty of a man's relations with his superiors, and that it is also an assurance against becoming a back number in the trade. But there is another phase of the subject that should be stated, and that is the disposition of one man toward another in revealing the "ins" and "outs" of the trade or in other words "setting the other fellow right" instead of giving him an evasive or erroneous reply, or of failing to improve an opportunity to give him information regarding the work.

Men will spend years in study to acquire knowledge of their work and through all these years they overlook one important fact, viz., that this knowledge must be not only taken into the memory in words and figures, but it must be fixed in the mind and properly assimilated, otherwise it is almost useless. Furthermore their real caliber is determined by their power not only to remember words and formulas but to digest and understand. The power to understand and to hold knowledge, is more or less dependent on the man. One with a good mind and memory has the advantage over the one with a mind less capable of retaining and comprehending trade lore. But whether the mind is great or ordinary there is one way of greatly aiding and increasing its power, both of assimilation and memory. This way is fully appreciated by psychologists and is generally conceded by all thinkers, but queerly enough it has been overlooked by many of our most zealous students.

It lessens the labor of acquisition of knowledge, and the man who drudges along without this help must work very hard to obtain even ordinary results. What is this great point? Well, the best known fixer of facts into the mind in relation to other facts possessed is the practice of "setting the other fellow right." "Give him the correct steer." Does this sound impractical? Do you want to read something more reasonable? Right here let it be stated that this is to "set you right," and if you will listen to the next few words you may see that, whether this is practical or not, it will aid any man who uses it as directed.

Be ready to tell each fact regarding the work to any one. Tell it in a way that will not hurt his sensibilities. Some very excellent men do not like to appear to be ignorant of any subject. Some excellent neighbors will pretend to know all there is to be known about any subject on which you may try to enlighten them, but don't let that hinder you from getting the facts to them in some way, nor let it deter you from telling them about something else later. Keep it up regardless of their surface bluff and do not let it appear that you feel that you possess a superior degree of knowledge. On the other hand, if you are a trifle human yourself, do not stop a man who is telling you something that you already know. Listen patiently; it will encourage him to come again, and next time or sometime he may bring an important fact that will pay for all your self-effacement. This scheme of being willing to be told and of aiding others is a most invaluable trick in the development of the mind. If this fact is ignored you will fall far short of the "possible" for your mind. Without this "fixing" method you can work and study until doomsday and between now and that day you will see neighbor after neighbor pass you in the game and you will find that long before you reach the end of your studying you have reached the unloading

stage. That is, you will have come to the time when you will forget as fast as you acquire. A little later you will finally reach a time when the forgetting exceeds the acquisition. Therefore, this is to "set you right" and if you get the idea you will begin to be an altruist for a selfish reason, if for no other.

Don't think your fellow-man will think less of you if you are willing to be told. Don't think you will be less agreeable with your shop companions if you appear less wise. People can't tolerate the man that knows it all. Don't think that you are giving away some trade secret which you alone should possess. Don't think that the other fellow will get your position if you let him into the "ins and outs" of the work. The other fellow can never catch up to you unless he is willing to aid others as well as to accept information. The real valuable trade secret is, "have no secret."

The psychology of the case is not so easy to comprehend, but any one can use his eyes about the works and see the results of the two extremes of secretiveness and openness in such matters. The advice to have no trade secrets is not intended for other arts or other times. It may or may not fit any other condition.

When a trade or art is in retrogression, or is not progressive, then the secret may be kept within a certain family or order, but the present condition of the work of machinery building is going forward. It has become so great that no one brain can master the whole art and it has not reached a stopping point. On every hand there seems to be a demand for men who have digested the greatest amount of useful information regarding this or that branch of the work. Such men have come into the world with a particular fitness for accumulating, digesting and using knowledge, but they have not made the most of themselves if they have failed to use this method of aiding digestion.

Stagnation of the individual and the trade is caused by trade secrets.

If we were to formulate some fundamental tenets for a doctrine of progress for the man, the following should have no minor setting:

Get interested by bringing the mind back to the work whenever it is caught wandering.

Aid others, whether they receive it loftily or otherwise.

Be willing to be told something that you already know.

Remember that the machinery world is too big for the biggest man. Your real size will be determined by your power to digest knowledge.

Working (practice) will aid you to understand and digest what you get from books, but you will not live long enough to do all kinds of work about which you should have a good knowledge. The next best means for aiding this digesting process is to supplement your thinking and reading by "setting others right."

THE LATHE OR THE TURRET LATHE

In the work of operating a turret lathe or any similar metal cutting machine, there must be the right understanding of the importance of the work and the opportunity it affords for a steady, reliable position or a stepping stone to other opportunities. Does it pay to operate a turret lathe? Is there not a greater chance in operating some of the machines which were called standard ten years ago? Is there not a better opportunity with the standard engine lathe for instance?

In answer to all such questions it is safe to say that the greatest opportunity lies in the line of use of the best implements. It would seem to be a self-evident fact that there can be no permanent gain for a man to

use an inferior implement. But so persistent is the time-honored notion that the standard lathe is the better machine from a workman's standpoint, that many a man is finding that he is not in the center of the procession of progress.

Most of our older men prefer the machines which they have used for so many years, and it is gratifying to know that, in the grand progress of the machinery building world, there are many demands for the good lathe hand, and furthermore the great volume of good lathes still being manufactured gives ample assurance that there will always be plenty of work for the older and some of the newer lathe hands.

For tool room work, the laboratory, and the general repair shop there is still a good place for the standard lathe. The turret lathe meets the requirements of the average machine shop, which is drifting towards specializing all the processes throughout the plant. Nearly all the lathe work of the machine building plant is now handled almost exclusively by turret lathes. The turret lathe is also being used in duplicating work in even the tool room and repair plant. Some of the older machinists may not know this or may for themselves disregard it, but the fact is there, and the newer men should know just where to go to get into the most rapid flowing part of the stream of progress.

In nearly all lines we go to the older heads for information, and it is generally a very safe thing to do. But there has been such a rapid advance in method and conditions, that in some instances the real facts are not known to even the men of the longest experience. The turret lathe, for instance, has been known for many years. It is the outgrowth of the little screw machine which was first made for manufacturing gun nipples. Thirty years ago it was sometimes used to make small screws in a machine shop, but then it was operated by a

boy and even he had to be forced into running it. He considered it no part of the machinist's trade to operate a screw machine or a bolt cutter. From this period to the present time there has been a gradual development of this machine for regular lathe work, until now, we have turret lathes and turret boring mills up to four foot swing. But all this time, and even to the present day, there persists the notion that it is beneath a machinist's dignity to operate one of these tools, and there has been a tendency to stick to the older implements, notwithstanding their actual inferiority, both for accurate product and duplicate work. The reason for this persistence of the original impression regarding the turret machine or any other thing may not be known. We do know, however, that it is human to hold to first impressions. We do know that it is human to stick to old ideas. These two facts would account for the survival of the old notion in the face of the contradictory evidence, but we have unfortunately one more reason for the view that the turret lathe is a machine for the boy to run and that it should be given the rougher work, and this reason is that there are all kinds of turret lathes, many of which are very much like the original screw machine. But this phase of the subject may be neglected for the moment. The point to be made here is that when you are trying to determine the real status of the turret lathe or any other implement used in the machine shop, you may ask the opinion of others who have been longer in the work and if their replies are conflicting, it may be necessary for you to think the matter out for yourself, bearing in mind the above statement that the most efficient implements must be the best.

Of course the trend of the times is making a great difference in the kind of tools that may be used. If the present turret lathes had been in existence thirty years

ago, there would have been very few users because of the scarcity of plants in which they could have been used. Duplicate work in machine building was almost unknown at that time. The micrometer gage, the general use of plug and ring and snap gages, was not known excepting in very small work that could not be called machine building. Just as there has been this change in the last three decades, so development is still going on. For this reason the turret lathe is being used beyond the practice of even a few years ago, and this change although known to many is not universally known, hence the conflict of views of some of the men who are best authorities on the subject of machine shop practice of the past.

THE TENDENCY OF THE MACHINIST TRADE

If you have seen clearly that the turret lathe is one of the implements of the future, then make your moves accordingly.

The next question to ask is, how has the coming of the turret lathe affected the opportunities of the trade? Has it taken away the opportunity to display skill and to make progress by an intellectual interest in the work? The turret lathe may be the lathe of the future and yet it may not be a desirable machine to operate. It may be useless to acquire a knowledge of its workings if modern implements have reduced man to a mere automaton. Then, maybe, this machine should be given a wide berth. These questions should be considered, not only by the new man entering the work, but also by each individual already there.

The trades of the watchmaker, gunsmith, locksmith and many others have changed in the past and it may be that the machinist's trade is undergoing a change unfavorable to the workers.

On all sides we see the daily introduction of machines which displace hand skill. In some instances these new machines are attended by boys or poorly paid unskilled workers. Is the trade of the lathe hand going that way? Some very well-informed men think it is, but the "very well informed" may not see far enough or rather they may see too far in the future to be of use as advisers for those now living on this planet. There is an economic question as well as a question of mechanics involved in the problem. It is the economic side that is frequently overlooked by the otherwise well informed.

Automatic mechanism can doubtless be invented and built for doing any kind of lathe work, but every one knows that it would not pay to make an automatic machine to produce one single piece which would never be duplicated. It may seem childish to introduce this extreme case when we know that this question of quantity should always be considered in choosing means for a given result. When we truly consider the economic side of the problem we will see that there are persisting conditions that will doubtless continue the use of the man and machine instead of the full automatic. Then we will see that although the millennium may not dawn until all work is performed by automatic machinery, while man rests in a thornless bed of roses, that now and to-morrow and ten and twenty years from tomorrow, there will be a good opportunity for men who know about machines which meet the economic and mechanical requirements of the time.

Whether a man's aspiration is to be a good worker or a director of work he must know about the best methods. The turret lathe may not be known as anything more than a back number in the next one or two decades, but it seems to come the nearest to meeting the present and probable future conditions. It seems to be the best stepping stone to the machine of the future, but

on this point no one is qualified to speak with any definiteness.

There will undoubtedly be new economic conditions in the future, but there seems to be on the horizon no change that will take away the value of the man's intellect which has been trained and developed in the operation of machinery. On the other hand, there seems destined to be the ranking of men according to their understanding of mechanism and economics. There is not one single reason for fearing the advent of machinery, and there are many reasons for getting in line with the drift of progress.

The new methods for producing work known as lathe work, should be thoroughly known by every one who intends to fit into the mechanical side of the machine building business; furthermore there are many of the positions in the business side that can best be filled by men having full knowledge of this work.

The prospects of the trade from a worker's standpoint and the value of this knowledge from every other individual standpoint, no matter how high his ambition or what is his ultimate goal in the machinery building work, both of these warrant each individual giving an important part of his time to the acquisition of the practical knowledge of the work.

Let us suppose the work is ultimately going down to within the reach of the less skillful. There is no reason why it should not serve as a present stepping stone. There is small prospect of the observing and earnest worker getting left behind in such changes. The future will probably continue the conditions of the present and past in which there seems to be a greater demand than supply of the better workman.

This demand gives each an opportunity fully equal to his endowments. The machinery which may be operated by the less skillful should be hailed with delight

by everyone interested in the welfare of the race, for such machinery provides a place for men who would otherwise be in less fortunate positions.

The one who operates a turret lathe primarily as a means of livelihood and the man who does so for acquiring knowledge of the methods in order to fit for other positions, should see to it that the interest of the work in hand is sufficiently intense to insure the best results of quality or output or both according to the requirements of the work. Such interest and action is almost an unfailing insurance against retrogression, and it is the best condition for progress.

The bogie of the trend of the times toward the degradation of the man has no terrors for the interested man. The man who pushes his work will go ahead regardless of the myriads of others all around, some of whom have had the great advantage of a thorough course in some good school of technology. There are so many who do not get their minds centered on their work, that it makes it comparatively easy for the earnest thinker and worker to hold his own or even go ahead in the procession.

In order to acquire a good understanding of the way lathe work is now being turned out, it is necessary to know the machines for this purpose.

The object of the present manual is to tell in general how turret lathes operate and particularly how the Flat Turret is constructed and how it should be used.

Although the subject must be treated in the simplest manner it is necessary to assume that the reader has some knowledge of lathes and lathe work. The beginner may find much that is beyond him, but nevertheless he should keep at it until it is fully mastered. This cannot be done without some chance to observe a machine in operation, or still better to operate the machine. The best way is to have study and work go on together. The study should take up sections that refer particularly

to the work in hand. Careless reading or reading without concentration will not be of much value. The best results in acquiring knowledge of this branch of machine shop work will be obtained by a reasonable amount of persistence combined with care in selecting parts of the subject that are the most interesting each day. If the work of the day has brought out some perplexing problem regarding the adjustment of the turners—read about turners and study the directions—do not try to digest such things when there is no immediate prospect of their being required.

WHAT IS A LATHE AND WHAT IS THE PROCESS OF TURNING?

We know that a lathe is a machine for controlling the position and motion of a piece of work and a cutting edge to pare off or whittle off some of the metal so as to leave the piece of work a certain form and size. In other words it is a machine for pushing a cutting edge against and into the work so as to cut or “turn” it down to the desired size and shape.

This work cannot be done by hand, because a man is neither strong enough nor can he guide a cutting tool with the required precision in its path through the metal.

We get the best understanding of the subject of the lathe when we think of it as a machine to force a cutting tool through the metal under very firm control as to its path and under fairly good control as to its velocity.

If we go directly to the study of its various parts without this bird's-eye view firmly impressed, we will wander about, dealing with details without a knowledge of their purpose and relationship.

On the other hand, when we have fully taken in the fundamental principles of turning and accurate duplica-

tion we will readily comprehend the purpose and operation of the details.

Let us see what stresses are encountered in the operation of cutting or turning metal in the lathe.

We refer to the process of turning or planing as "metal cutting." This term "cutting" is misleading; the process is more analogous to scraping. To the average mind "cutting" means a process like cutting cheese, or bread, or whittling wood, in which the parts separated are not greatly deformed. In splitting wood the two pieces separated are seldom crushed. The structures of each are seldom changed by splitting. The same is true of cutting bread, cheese, etc. In whittling wood the shaving is more or less deformed. It seems partially broken, particularly if the wood is a trifle brittle, but in turning metal the "chip" or the cutting is greatly deformed.

A chip from a lathe is a piece of crushed metal in which the structure has undergone a great change as it is pushed off by the so-called cutting tool.

We must continue to call it a cutting tool in order to use the conventional terms, but we must bear in mind that it is not analogous to either whittling or splitting.

The chip produced is usually twice as thick as the metal was in the work and it is about half as long.

The chip is a series of chunks scraped off and stuck together in the process. The tenacity of their union depends on the ductility of the metal, and the acuteness of the cutting angle of the tool.

Cast iron chips are very loosely united and may be easily broken apart by the fingers, whereas cuttings from soft stringy steel are sometimes very tough, especially if produced by extremely thin or acute edged tools; but all chips may be safely classed as crushed metal scraped off from the work by a powerful machine. Even the

weakest machines in this connection may be considered powerful, but so great is this stress and so wholly does it tend to throw the cutting edge off from its true path that the strongest of the powerful machines do not give wholly satisfactory control.

These facts must be accepted on faith at first because the modern machines do not give an operator a chance to know either the direction or the force of these stresses.

In the old days of very weak lathes and of hand turning, each lathe hand had a fairly true conception of the cutting stresses, but the modern machines lack that sensitiveness which conveys these facts. That is why you must understand what is going on when a lathe is cutting, in order to fully appreciate the need of getting tools and work most securely held and controlled.

An ideal cutting edge would act as a sharp plow, cleaving the chip away and pushing it just far enough to one side to allow the thin cutting edge or plow point to advance, but such conditions are not attained even with the most acute cutting edges in use.

In regular practice the chip is formed by a tool that scrapes. The scraping process is a crushing process. The metal scraped off may be a continuous piece, but it is composed of a series of crushed chunks of metal more or less firmly united.

It does not matter whether the tool or the work moves or whether both of them move; for the motion that concerns us is the motion of the cutting edge through the metal. This motion may be steady but the chip formation at the tool point is intermittent.

The cutting angles are never acute enough to make a good slipping angle for the chip; hence the advance of the tool through the work does not cut away a continuous ribbon, but instead the chip flows and slips over the edge by jerks. It halts and piles up on the edge

until it gets a certain wedge-shaped chunk of crushed metal, and when this accumulates to a certain size the chunk partly shears off from the work and slides along, and then the process of building up a new chunk begins. These wedge-shaped chunks lie crosswise of the chip and their length is approximately about double the rate of advance or "feed" of the tool in the work.

The proportion varies with different cutting angles and metals and the intermittent flow of the chip is more in cast iron than in turning softest steels, but if we are to know what stresses must be resisted by a lathe we must know what is happening at the point of the tool. This knowledge once possessed puts one in position to correctly solve many problems of work that are perplexing to those who do not know what is going on at the place where the stresses start. This intermittent formation of the chip doubtless results in the intermittent advance of the cutting edge, but this we might neglect if it did not in turn tend to cause the cutting edge to deviate from its true path. It is this tendency to deviation from the true path that makes it necessary to see to it that the tools and work are most securely affixed to the machine.

There is a great difference in the degree of control of the various machines, but that is not within our present province to treat. Nevertheless it is well to know that no amount of care in setting tools and holding work can offset the frailties of a poorly designed machine.

The tools should, if possible, be unyielding in themselves. They should be the stiffest part of the connection between the cutting edge and the work. Of course, there are many cases where long, slender, overhanging tools must be used, as in boring a long hole of small diameter, but in all operations in which the tool is held by one part of the machine and the work by another part, with no chance of controlling the path of

the cutting edge excepting through the machine control, then it is of great importance to see that the tool and the work are most securely mounted. The exception to the kind of work stated is work in which the cutting tool is allowed to ride on the work by being connected to it by back-rests, as in turning bar work, or by having a center bearing in the work, as in counter boring in chuck work.

In all cases where the tool has a riding connection with the work there is comparatively no quivering, and its product is more uniform than where the whole control must reside in the machine.

In bar work nearly all tools get the riding contact, but in chuck work it has been found impractical to use such tools on the general run of work coming within the range under consideration. Hence it is necessary to make a distinction between the process of cutting in the two kinds of work, and to know the importance of the right control of the tool when it is held into its work with no steadying contact thereon. We may disregard the bar working tools because there is little or no chance to vary their mounting, but every other tool should be mounted in the firmest possible manner.

Perhaps it would seem enough to say just so many words without giving the reason, but we know that that would make no impression that would be lasting.

The fact that a cutting edge must be pushed along a true path against such odds as an intermittently flowing chip, will bear home to each one the need of seeing to it that each tool has a good seat in or on its holder and is firmly clamped against that seat, so as to resist the stresses which come from almost every direction.

In order to obtain this control it is necessary to hold the work as securely as possible and to mount the tool in the most rigid support. Since the work must be

rotated, it is held on the end of a spindle which is journaled in what is called the headstock. The bearings for this spindle are provided with adjustments by which they may be set up to compensate for wear, and these bearings should always be adjusted as closely as possible without binding the spindle. The spindle must be free to turn without heating, but there should be no lost motion.

There are several ways and means by which the work is attached to the spindle.

The circular vises called chucks are generally preferred on account of their convenience of operation, but it is occasionally necessary to resort to the use of a face plate and clamp or even the arbor in its various forms from the simple solid plug to the complicated expanding arbor. Whatever means is employed the importance of making the work rigidly integral with the spindle should be borne in mind. This calls for a most unyielding attachment of the "means" to the spindle as well as the work to the "means."

In bar work this makes it necessary to see to it that the work extends no further beyond the chuck than is necessary to do the work and in chuck work more care should be taken to grip the work in the most favorable manner consistent with the character of the cuts to be taken. Of course the work must project beyond the face of the jaws far enough to allow the action of the cutting tools and yet there must be enough of the piece left in the jaws to permit a firm grip. The importance of firm grip is to get firm control. A firm grip on a 2-inch diameter hub of a 12-inch diameter gear would not be a very good controlling grip. The bearing of the jaws on the work should be at or near the large diameter if possible. If the 2-inch hub is very long, say the full length of the inner face of the jaws (about 3 or 4 inches) a fairly satisfactory control may be obtained but it is always best to get the large diameter grip.

On some kinds of chuck work, as for instance gear blanks, this is obtained on the inner side of the gear rim. A gear held in this way may be turned all over the parts usually finished without a second chucking.

If the operation is only some light cut near to the chuck face the gripping problem is of less moment, but on nearly all work a careful consideration of the means and way of holding is of utmost value.

SOME FLAT TURRET LATHE FEATURES

So great has been the need of firm control of the work that nearly all lathes are built with the headstock firmly bolted to the main frame of the lathe which is called the bed casting. In fact in many lathes the head and bed are cast integral in order to insure the most unflinching control of the spindle as it carries the work.

In the Flat Turret lathe the fixed headstock has been abandoned. The object of giving up this apparently ideal condition was to avoid certain weaknesses that were entailed by putting all the sliding joints in one place.

In order to get the same relative motion between the work and tools, all other lathes provide tool mounting with the necessary motions. Although the cross sliding head cannot be as firm in relation to the main bed casting, it is actually a scheme by which the firmest control of the position of the work and tool can be secured, on account of the simplicity of the tool slide, which is made possible by putting one of the slides under the work-carrying head.

The rate of rotation of the work must vary with the different diameters, in order to get a uniform rate of speed of the cutting edge through the metal, and also to provide an opportunity to run speed suitable to the kind of metal being turned. For this purpose the head is

provided with a system of gears and friction clutches by which nine speeds may be obtained. These gears and clutches are arranged on three shafts standing parallel to the spindle and in the same horizontal plane and these shafts and spindles are all encased in a shallow pan-shaped headstock. The headstock contains enough oil to allow the lower edge of most of the gears to run submerged and these gears throw oil over all others and all bearings of the drive and spindle.

The nine speeds are obtained by the two levers directly in front of the chuck. Each lever has three positions. The middle position gives the slowest motion and the extremes to the right and left give the medium and fastest motions. There are two friction clutches and one silent ratchet clutch for each lever.

The silent ratchet clutch picks up the motion when the frictions are disengaged; thus the middle position of the lever gives the ratchet speed. It engages and disengages without shock, for it only picks up the motion when the shaft becomes retarded to the ratchet speed.

In addition to the two levers for the nine speeds, there is the regular shipper rod over the entire length of the lathe, which connects with a lever which gives the forward motion, the stop and the backward motion, the same as on the standard lathes. That is, the position of the shipper lever is the same and its operation accomplishes the same results, but the means is peculiar to this lathe. It does not connect to a counter shaft. It gets its results through the mechanism in the headstock.

The adjustment of the friction clutches for the speeds and for the forward and reverse is effected by turning the adjusting collars on the transmission shafts just outside the head casing. These should be adjusted with care. An over adjustment of one sometimes prevents the correct action of the clutch on the opposite side.

"Flat Turret" is a name given to the plate shaped tool holder which has been so called in order to distinguish it from all other forms of revolving tool holders.

This plate shaped tool holder is mounted on a low carriage. Its connections to the carriage and of the carriage to the bed of the lathe are the most direct consistent with the requirements of a turret lathe tool holder.

The object of the turret is to bring the tools, one at a time, to the work. In order to bring each of these tools in working position the turret must have a rotary seat on the saddle of the carriage and there must be a most accurate and strong indexing mechanism for turning the turret, arresting it in the proper place for each tool with greatest precision and for firmly holding it there during the operation. Any lack of accuracy in the control of the locking mechanism directly affects the position of the tool in relation to the work.

If the locking mechanism fails to accurately return each tool or if it yields to an uncertain extent under the stress of the cut the work produced will not be uniform.

The variation will affect all work more or less, but it becomes most serious in chuck work in which the tool and the work are usually held wholly by the machine without any chance for the tool to get a riding contact on the work. If the turret yields .001 of an inch the work will be off in size at least .002 in diameter.

The least effect of turret error is found in machines in which the locking mechanism works at a good distance from the turret center and the tools extend the least beyond its locking device.

If the tools are allowed to project unnecessarily beyond the turret locking bolt then the errors of the locking mechanism are multiplied at the tool point and the error due to looseness of center bearing of turret is also added.

These points are not insignificant. Each one of them should be known to every one who intends to see that good work in large quantity is turned out by the turret lathes.

The flat turret is held down to its seat on the saddle of the carriage by an outside clamp-like gib. This gib should be adjusted to snugly control the turret, but should be loose enough to allow the free turning. In setting down the gib screws, go all around the turret, bringing down each one until it binds the turret, then let it back enough to leave the turret free. After going all around in this way the gib screws near the working position may be set a trifle closer than those farthest from the work.

The flat turret is mounted on a single slide carriage. This gives a motion to and from the chuck but no cross motion, the cross travel being obtained in this machine by moving the work-carrying headstock. This head is called the Cross Sliding Head. Notwithstanding the simplicity of this single slide turret carriage it is necessary to see that it is snugly gibbed to the guides of the bed. These guides are usually called "shears," "Vs" or "Ways."

The gibs for the carriage are provided with adjusting screws which draw the gibs toward the under face of the ways and counter adjustments which put these screws under stress, thereby taking up all slack without allowing the gibs to bind on the shears. The screws which hold the gibs up to their work are cap bolts and the counter adjustments are set screws which hold back against the pull of the cap bolts. These two should be carefully adjusted in relation to each other so that the gib will stand close to the guiding surfaces under severe stress. These provide a most unyielding scheme of gibbing—one that allows the free movement of the carriage without having the gibs and gib screw slack.

The greatest yielding of the carriage under working stress then becomes only the slight necessary looseness of the gibs to the guide.

The gibs at the working end of the carriage should be adjusted closer than those at the other end. But both sets should be close, because those at the working end of the carriage are subjected to lifting stress in work having a feeding stress such as required in drilling or in turning with a square-shouldered dull tool. It also has the side thrust of the work, which may lift one and depress the other, in its tendency to rock the carriage on its guides or hold it over to one side.

The gibs at the back end of the carriage (that is the end farthest from the work) must be carefully adjusted in order to meet two important stresses. The side thrust of the work, particularly if the tool extends an excessive distance beyond the turret edge, as for instance in boring with heavy bar, and last but not least these gibs must be set in order to aid in holding down this part of the carriage when the forward motion is arrested by the stops.

THE STOPS FOR THE CARRIAGE

The carriage is moved on its guideways either by hand or by the power feed. In ordinary practice the hand control is used mainly for quickly moving the carriage when the tool is not cutting, although in some cases the tool is forced into the cut by hand; but whether moved by hand or power it is desirable to determine to a nicety the exact extent of travel. In fact, the degree of precision with which a machine controls the dimensions of the work is one of the principal points by which it is rated, and the same holds true of the worker. Accurate duplication requires a good implement and a good skill and knowledge on the part of the worker. A true understanding of the stop mechanism and what

it must accomplish is absolutely necessary in order to correctly understand or operate a turret lathe. Unfortunately, the stops and stop mechanism are out of sight, but if the scheme of action is once understood the mystery of turret lathe control is very much lessened.

To begin with, stops must serve two purposes — first they must arrest the power feed and second they must constitute a firm abutment against which the carriage may be located with extreme precision.

The stops for the turret carriage not only determine the shoulder position in turning a stud or shaft but these stops determine all dimensions which are effected by movement of the turret slide. This includes thickness of flanges, depth of bored holes and shoulder and face position on all work. The precision required for this result in chuck work is frequently extreme.

There are many elements which operate to make the stop control unreliable. The stress required for feeding the tool widely varies. Even with the same tool and cut a change in the hardness of the metal may increase the stress. The same tool as it becomes dull may require a much greater force to hold it into its cut, and of course varying depths of cut constitute another variant, which directly affects the feeding stress.

The variation in the stress required for feeding would be of little consequence if it were not for the fact that this stress springs (distorts) every yielding part of the machine; it takes up the slack of all the joints all in one direction, which results in tipping or canting the carriage on its ways; and these, combined with all other yielding parts, make a total result in which there is a great change of position of the tool point in the work. Of course, if the work and tool were fed together by a feed which pushed, or still better pulled, directly in line with the stress, and if the stop were located along this same line with an unyielding relation to the work and tool,

then the varying stress could be ignored, but as the case stands the carriage is fed by a mechanism that pushes it forward at a point very remote from the line of stress of the cut and even this could be ignored if it were possible to locate the stops so as to stop the tool when it reached a certain position in the work regardless of where the remote corner of the carriage happened to be. But in all turret machine design there exists no such ideal condition for either the feeds or the stops. In some machines the stops are at the most remote corner of the carriage apron. In the Flat Turret lathe these stops are directly under the carriage saddle, snugly nested in the top of the bed casting. Since the tool cannot be arrested in relation to the work, the next best thing is to arrest it in relation to the bed, and the best place on the bed is that which is nearest the line of stress. That is exactly where the Flat Turret lathe stops have always been located—in the top of the bed snugly nested together.

This point is not introduced here as a criticism of all other lathes. It is set forth as a concrete example to illustrate the real conditions under which stops must act, and this must be appreciated in order to truly comprehend this important phase of turret lathe practice.

The Flat Turret lathe carriage is carried forward by a feed which, although powerful beyond the requirements of the cutting stresses, is allowed to yield when any positive obstruction arrests the travel of the carriage. The stops, therefore, of the Flat Turret lathe serve both as a means to arrest the feed and to furnish a positive stop of great precision. They do not disengage the feed, they simply arrest the carriage and the feed continues to pull at the carriage at a predetermined stress; this not only serves to hold the carriage firmly against the arresting abutment with a known pressure—a pressure that is uniform and insures a uniformity of work not otherwise

obtainable, but it also allows the cutting tool a chance to "smooth up" the face of the shoulder.

The stress determining mechanism is called a slip collar. It connects the feed worm to the feed rod. Its tension may be adjusted by use of a special side spanner wrench; but it should never be set tight enough to pull the stops along. It should be adjusted just strong enough to feed anything excepting a dull drill or a drill with a chip caught over its lip.

Never set this up to prevent slipping when drilling unless you are sure the drill is reasonably sharp and that the slipping is not due to a chip riding over the lip. This last condition frequently happens in entering a drill a second time into a hole.

Original turret lathes had only one stop for the turret, the various lengths of cut being obtained by varying the length of the tools, but all of the Flat Turret lathes have been provided with an independent stop for each position of the turret. The original machines have six stops, and the present type have a double set for each position, which makes a total of twelve. The stops consist of twelve adjustable arresting members attached to the bed and co-acting members in form of flat bolts nested in a vertical pocket in the carriage and so controlled that any one of these may engage at a time. The members attached to the bed consist of notched bars about 4 feet long by about $\frac{1}{2}$ x $\frac{3}{4}$ -inch thick. These are placed side by side with the notch uppermost. The bars are numbered A-1, B-1, A-2, B-2, up to A-6 and B-6. This furnishes two stops for each of the six positions of the turret. The flat bolts in the turret saddle are all but one held up so as to allow just one at a time to ride along on its stop bar and drop into its own notch when it reaches that point in the travel. This one gradually descends into its notch on the inclined side thereof, and there it hangs until the carriage has advanced a trifling

distance when it comes squarely against the square side of the notch in the bar. This puts a pulling stress on the bar under which it is the least likely to yield. The bolt is subject to a square shear across its width of $1\frac{1}{2}$ inches. The seat of the carriage latch in its pocket carries the resisting edge close to the opposite resisting edge of the notch in the bar and this constitutes a most unyielding stop.

The bars are clamped and firmly held in the bed by a single set screw which binds them all together sideways. Each stop bar is also provided with an independent screw controlled by screw driver by which each stop may be held during the adjustment of others; but these independent screws should never be set down very hard because setting one loosens its neighbor and this process continued will finally split the casting. These independent screws should only be depended upon for holding stops during the process of adjustment and should never be expected to withstand the pull of the carriage. The $\frac{3}{4}$ -inch set screw at the side of the stop may be set up with any reasonable stress for a screw of its size and it may be relied upon to hold the stop bars against the normal pull of the feeding mechanism.

The control of the stop members in the carriage is not difficult to understand if a little attention is paid to the construction. As stated, there are twelve stop bars in the bed which may be set with their notches in twelve different positions, and of course there must be corresponding members in the carriage to co-act therewith.

The turret carries six tools and each tool must have at least one stop. In some instances one tool may require five or six stops and the others may get along with the remaining number but in the ordinary practice one or two stops for each place will meet the requirements.

The stop bolts or latches which travel with the carriage are of two kinds. The regular stop bolts consist of a bunch of twelve flat bolts each measuring $\frac{3}{8} \times 1\frac{1}{4} \times 2\frac{1}{2}$. These are contained in a vertical pocket at the foot end of the carriage. The auxiliary stop bolt consists of a round $\frac{5}{8}$ -inch pin, which may be placed by hand in any one of the six holes.

The auxiliary stop pin is only required when more than two stops are required for one or more positions.

The bunch of twelve may be considered the regular stop used in general run of work. These stops are controlled by the turret in pairs, an A and a B stop for each of the six turret positions. A hand lever supplements the turret control to the extent of allowing either the A or the B stop to engage.

The turret positions are numbered from 1 to 6 to correspond with the stop bars in the bed. When the turret tool occupying position No. 1 is in working position then the turret allows the pair of stop bolts over stop bars No. A-1 and B-1 to drop down. In order to prevent both engaging, a comb-like lifter is moved end-wise so that its comb teeth register with either the A or the B stops and this stop lifter is actuated by a handle at the foot of the turret carriage. This lifter holds either all of the A or all of the B stops up out of reach of the stop bar, and this allows just one of the others to drop down on the stop bar, for the turret holds up all but one pair. In operation this one lone stop bolt rides along on top of the stop bar until it reaches the notch; then it gradually descends the beveled incline of the notch and awaits the arrival of the square shoulder of the notch. This it meets unyieldingly and arrests the carriage. In using only one stop for each position of the turret this lifter may be set and left in the position marked "A stops in." Then of course the "A" stop bars would be the only ones adjusted.

If two stops are required for one or more positions then a "B" stop should be set for such places and the stop lifter should be shifted from "A stop in" to "B stop in" at each place where the two stops are required. If more than two stops are required for one position, then recourse must be taken to the auxiliary stop pin and it may be put in any hole that registers with any stop that is not required for other service.

The double stop scheme may be used for two kinds of work. One set may be kept adjusted for one job and the other set reserved for other work.

There is a center position of the stop lifter by which all of the stops may be lifted out of engagement, so that the carriage may be run past the stops.

If the stop is required for arresting the motion of the carriage when travelling backward—that is, away from the chuck—then the extreme end of the stop bar is used as an abutment. See to it that the stop bar is turned over so that it presents a square corner, for the beveled corners of the notched side will not engage the stop bolt of the carriage when the carriage is moving backward.

The usual way to set the turret stop bars is to release the clamp screw which binds all the bars together and then release the set screw which is directly over the stop bar to be set, but keep the set screws down on the other bars, particularly on the stop bars each side of the one which is to be moved. By leaving the stop bar free, the carriage stop bolt may be allowed to draw this stop into the desired position and there it may be clamped. By following out this process each stop may be set without disturbing its neighbors.

By all means do not try to work without the stops.

The advantage of the turret lathe is its ability to duplicate work. If you use the "cut and try" method of getting shoulder lengths or try to measure each one, you are on the wrong track or machine.

If the work requires the carriage brought against the stop by hand instead of power feed, then see to it that the pressure by which the carriage is forced against the stop each time is uniform. The position of the tool is changed by a greater or less pressure against this stop even in this machine. The tool is not only changed in its relation to or from the chuck, but it also shifts a trifle sideways, this not only changing the position of the shoulder but also the diameter of the work at that point.

When the carriage is to remain fixed in one position, as for instance in facing, the carriage may be clamped to the shears or guide-ways by the binder lever near foot of saddle.

STOPS FOR THE CROSS SLIDING HEAD

The stops for the cross sliding head are even more important than those of the turret carriage, for the head stops determine the diameter in nearly all chuck work and some of the bar work. Although the head stock is not generally changed from central position in the regular run of the straight bar work, there is a use of this feature in work which combines the regular bar working tools with one or more chuck work operations; therefore, the functions of the cross sliding head stops should be fully understood.

The importance of a correct use of these stops will be recognized when it is known that the same canting and tipping effect takes place in the action of the carriage stops and also disturbs the head position.

In the head an unequal pressure changes the position of the work in relation to the tool as to its diameter and also as to the alignment of the axis of the work with the travel of the turret slide. This is exceedingly small with reasonable care but it may be very great under anything less than reasonable care.

The disturbing effect is mentioned in order to make sure that the means are properly used. There is a stress indicator by which it is easy to see that the correct stress is given each time and there are gibs that should be adjusted to run freely, but these gibs should not be allowed an excessive slack.

The stops for the head are very nearly in direct line with the cross feed screw, which really gives the maximum stress against the stops. The ideal position for the stops and cross feed screw would be in direct line with the cutting stress. But neither the stops nor the screw can be so located, therefore, the next best condition is to have the stops and screw as near together as possible and both of these near the cutting stress and guiding rail. This last condition is obtained, but nevertheless there is a slight disturbing effect caused by the operation of these stresses.

These facts are not known by the average worker, but the progressive man should know them, so as to use the means provided for reducing the disturbance to the minimum. With these points understood, any reasonable degree of care will insure good work; but a total disregard under some conditions produces poor work.

Always see to it that the gibs on the side of the guiding rail are properly adjusted and that the gibs which resist the lifting tendency are also properly adjusted. Do not set up the gibs at the left hand side of the head any closer than just in contact. If these bind they tend to make the head cant either one way or the other according to the direction of the stress of the screw.

There are ten stops for the travel of the cross sliding head. These stops are in no way controlled by the turret motion. Each stop must be brought into operative position by hand.

The stress indicator carries a pointer which moves under the stress which is brought against the stops

by hand. By observing the motion of this indicator results in extremely accurate duplication of work may be obtained.

Supplementing the stop mechanism for determining the position of the head there is a central stop against which the head may be returned whenever the work requires it. This central stop on some of the later machines may be thrown out of engagement so as to allow the travel of the head about two inches forward of the central position.

The precision of the central control so far exceeds the possible control of the turret tools that this may be considered absolutely correct.

The power feed mechanism for the cross travel of the headstock is driven through a slip box or collar similar to the one which has been described for the turret carriage travel. This measures the pulling power of the feed and allows it to stop when the head is arrested by any positive obstacle like a stop.

In addition to the stops for locating the head to a nicety, the hub of the cross slide screw is graduated and provided with numbers and an indicator by which the screw may be returned to any desired location. This graduation is sometimes used to supplement the stops, either to indicate the exact position of the screw when against the stop, or to locate the head independent of the stop. When this is used without the stops it is of course necessary to see that the slack of the screw in the nut and thrust collars is taken up in the direction against the stress of the nut.

TOOL "SETTING" AND MACHINE IDLENESS

Next to and closely allied to the subject of stops is that of tool "setting." It is necessary, to get the best results in quantity of output, to run the machine at speeds and feeds that do not allow a very long life to

the cutting edges of the tools. Just how long this should be depends on the difficulty, delay and expense of sharpening and resetting. The regular turning tools for bar work and many of the cutters for chuck work should be pushed to the extent that will make necessary a new cutting edge every five hours at least, but this may seem a very short period to the man who has not mastered the stop problem and who has given little thought to the quick-accurate replacement of a dull tool by a sharp tool.

The quick-accurate replacement of a cutting tool frequently results in doubling the output of the man and the machine. It takes a little more thought and in many cases makes a busier day, but if the game becomes interesting it is not a harder day's work and if there is an ambition to get ahead this is one of the places where it should bear evidence.

Every one knows that a machine should never be idle any longer than is absolutely necessary. It is idle during the interval of turning the turret to bring a new position and tool, it is idle during the time the slide is being run back and forth without cutting, it is idle when using time puttering about the size of the cut. An interest in the game will see to it that the instant the cut is finished the turret carriage is quickly operated and the next tool brought quickly to cutting position and the feed quickly thrown in.

A marked difference exists between the way in which a machine is handled between cuts, whether it is the chucking a piece of work or changing the turret from one position to another, or the greater delay of putting a sharp tool in place of a dull one.

Replacing a dull tool by a sharp one should not include the time of grinding. The grinding should be done in the tool room, for the machine should not be delayed for such operations.

The new cutter should be placed with the greatest care to get it just where the old one was located.

Care exercised in the matter saves time in tinkering with the cutter after starting and trying the cut and it also saves re-adjustment of stops.

In some of the boring bar cutters this accurate placement of a new tool may be accomplished by measurement of the exact amount that the dull tool projected beyond the boring bar in which it was held.

It is not a great difficulty, just an ordinary matter, but it is a key to many schemes by which the output both in quality and quantity may be increased.

The whole secret lies in cutting down the various periods of machine idleness. This becomes a habit — it soon becomes the natural thing to do — just as the indifference regarding the machine idleness becomes a habit and the only thing a man can do, no matter how hard he may try to put up a temporary hustle for some spectacular effect. If this idea is fully comprehended in its full economic effect, a very great change will result in the easy output.

QUALITY OF FINISH

The character of the finish produced by the cutting tools is something that requires the greatest care and attention. Even with these, the results are not always as expected but there are some points if heeded that will be of assistance in grinding, setting and feeding cutting tools.

Cutters for the modern turret turners for bar work, in which a back-rest firmly holds the work and tool together may be left with a sharp corner where the chip is severed from the finished surface, but any cutter that must depend on the entire machine to hold it into its cut must always have a rounded corner. The sharp point or corner of the cutter is quickly destroyed when

a tool must work without the steadying effect of the back-rest and even if the corner is not worn away rapidly, the surface produced by such a tool is not satisfactory; but in the turner with the aid of back-rests, the corner holds its own very well. A square cornered tool with a straight cutting edge removes the chip with the least stress.

A square-cornered tool does not leave a smooth finish, but this does not matter in the turner because the surface is polished or burnished smooth by the action of the back-rest. There are many pieces of chuck work that require a square-cornered tool; but it does not stand as well as a tool having a rounded corner. On the other hand, there are cuts to be taken by the back-rest turner which require a tool having a rounded corner. One of these cases is found when the cut is not deep enough to put sufficient thrust against the back-rest to get the burnishing effect, and another case is where a coarse feed is demanded more than true work.

The tendency of the turner is to turn true work if the corner of the cutter is not rounded very much, but an excess round generally results in the work "running out" of true. But with the chucking work, or any work in which no support connects the tool to the work there is not the tendency to run out of true and there is a tendency to quiver to an extent that produces rough work and destroys sharp corners of tools. The nicely rounded tool should be used on as much of the chuck work as the nature of the shoulder required will admit. Of course if the cut is short and if the shoulder must be "square" it is best to use a "square" or sharp-cornered tool, but always try to use a rounded corner when it is possible without greater loss incurring.

The cutting angle may vary from 65 to 70 degrees for all general purposes, but may be made of 60 to 65 degrees for regular turners and 55 to 60 degrees for the sharp cut turners.

CUTTING SPEEDS AND FEEDS

The speeds should be determined by the tool endurance and the length of time it takes to put a sharp tool in the place of the dull one. This does not require a great table of data; it only requires a good intention and clear head, with a fair knowledge of what modern steels are doing.

The rapid advance of high speed and long endurance cutting steels is continually pushing the possible results farther and farther forward. Ordinary open hearth steels may now be turned at speeds ranging all the way from 50 to 250 feet per minute according to the rate of feed, the quality and quantity of cooling medium and the quality of surface required. If you have tried to run 125 feet per minute and you find the tools will not stand up under the stress, do not let your whole life be changed by that experience. It is barely possible that the steel was not of good quality, or it was not properly hardened, or the work was extra tough. Do not let that settle the question of speed. See to it that you get the greatest results.

In turret lathe work the cutting speed may be safely rated according to the periphery speed of the work and thickness of the chip. The depth may be generally neglected, especially in bar work, because the deeper the chip the lesser the inner diameter and consequent running speed of that part, therefore the outside diameter may be taken as the only necessary factor excepting feed. The running speed is measured by the number of feet the bar of work would roll if it were allowed to run on the floor at the given speed. For instance, a $3\frac{7}{8}$ diameter measures roughly one foot in circumference. If work of this size is run at 100 revolutions it would roll 100 feet per minute on the floor; hence its cutting speed would be 100 feet per minute. A piece of work half that diameter would be running only fifty feet per minute at that speed of revolution.

A cut-meter like the Warner Cut-Meter saves figuring and registers the surface velocity. If the work is being continually changed it is necessary to have a cut-meter within easy range or resort to the table of speeds furnished with each machine. The table will show the positions of the speed controlling lever for any size of work at any selected number of feet per minute velocity.

In turning steel the speed is directly affected by a change in thickness of chip. (This does not apply to cast iron.) By thickness we do not mean width. In order to make it doubly clear, let us take an example. In turning a 2" bar down to $1\frac{1}{4}$ " diameter the total reduction is $\frac{3}{4}$ " and of course the depth of the cut is $\frac{3}{8}$ ". The feed for a cut of this kind may be anywhere between 90 and 60 per inch. That is, at 90 per inch the work must turn around 90 times to make the tool travel one inch, and at 60 it turns only 60 times during the advance of the tool 1". The width of the chip would be $\frac{3}{8}$ " and the thickness would be equal to the feed plus the thickening due to distortion. As already stated, the thickness of a chip is generally at least double the rate of feed because the chip is made up of crushed chunks packed together; but when we are determining the rate of speed in relation to the feed we may for practical purposes compare the feeds directly, ignoring the deformation of the metal. The actual deformation undoubtedly plays an important part in lowering the speed, but we shall not try to take it into consideration. Therefore, let us say, for purposes of comparison, that a feed of 90 produces a chip that is only one half as thick as a feed of 45 per inch. The speed of the 90 feed might be 100 feet per minute. If so, then the speed for the 45 feed would be 50 feet per minute. By this we see that under the present conditions of high speed steels there is no gain in the coarser feeds; in fact, there is a loss of accuracy of product. Remember

we are talking about turning steel in general turret lathe practice and particularly in the Flat Turret Lathe. These statements undoubtedly hold true far beyond the limits of these machines, but that is not for us to determine at this time.

In this Flat Turret practice then, there is no gain in cutting thick chips, excepting on brittle soft metal like cast iron, in which the metal is crowded or pushed off with the least semblance to cutting action. A chip produced by a broad tool fed rapidly over the work would be wide for feed and thick for depth, or a broad tool used for forming would get a chip which in thickness would correspond to its feed, but in all cases in turning steels and other tough metals it is the thickness of the chip which affects the speed.

With the carbon turning tools and the former conditions the directions for getting out the largest quantity of work were just the reverse, viz., make your feed as coarse as the work will admit and then take all the speed the tool will stand. This is still a good rule for turning cast iron. The general impression under the old scheme was that a thickening of the feed did not make a corresponding reduction in running speed, and therefore there was a net gain in the coarser feeds. But in the present circumstances there is no gain in the coarser feeds and there is generally a serious loss in both the quantity of the surface and the trueness of the work.

It does not follow that a feed of 200 or 400 per inch would be better. There is a practical rate of speed for each machine and work. A glance at a piece of work turned at a feed of 100 or 120 per inch in the Flat Turret lathe or any lathe of its size will show a very unsatisfactory surface, providing your eyes are good. If the feed is too fine the cutting tool is not held into its cut with a steady stress. This may not be evident in the chip produced but it is clearly shown by the scratched

and burnished appearance of the work. With a feed that is too fine the tool alternately rides and digs, that is, it rubs along for one revolution or more and then it digs in. When it rides it produces a shiny surface or ring, and when it digs in it produces a scratch. These two alternate at uneven intervals along the work and make a very unsatisfactory surface. When the phenomenon of metal cutting is fully understood we may know what causes these results, but at the present time it seems to be due to the accumulation of crushed metal on the tool point. This accumulation prevents clean cutting. There is generally a variation in the amount and the form of this pile. This change in form and shape of the pile of metal on the tool point produces the variations noticed in the finer feeds. This phenomenon is more or less in evidence at the coarser feeds and is noticeable at the highest cutting speed, particularly when the tool is run without water or other lubricating and cooling medium. We may dismiss the cause of the poor results of the fine feeds and just remember that in the Flat Turret lathe no feed finer than 80 or 90 should be used for regular turning. The finer feeds should only be used for drilling and broad tool work. In turning steel do not use feeds coarser than 80 excepting where the cut is only a skimming cut of very slight depth.

Owing to the irregular progress of the art of making steel for metal cutting, no definite statement as to possible cutting speeds can be made. This must be determined each year and on each class of work.

FINAL WORD ON PERSONAL SIDE

The great point to be made is to be sure you are not running speeds that have been chosen by experience gained when using extra poor tools or in turning extra tough work. No amount of explanation can make up for having struck a slow gait. A slow gait becomes a

habit, and it is in constant evidence, despite any attempt we may make to show a spurt of speed. If the slow habit has become fixed, if the time hangs heavy on your hands in waiting for quitting time, it is probably because you have no keen interest in the work. Your interest in the work cannot be built up by some great resolution. It is almost useless to make a great spurt hoping to catch the fever of intense interest. There is the easy way already set forth in the preceding pages but repeated here because of its direct connection to the subject of speeds, feeds and the reduction of the idleness intervals of the machine. This interest is not acquired in a minute or a day but it is built up by bringing the thoughts back to the work whenever they are caught wandering in "dreamland" or "grudgeland" or in "indifferentland." This is not a scheme of self-torture for later glory, — it is an easy way to a comfortable and most reliable scheme of individual progress. Do not hesitate to follow this plan just because you do not think the brain can be led into interest in any subject in this way. It will operate just the same whether you know or not. It is a law of nature to which we must conform if we wish to get the most out of life with the least effort. The brain works naturally in grooves. You will get the habit of thought by bringing your brain back to the work whenever you catch it wandering. Don't worry about becoming a freak by over-concentration. Such cases are rare. What most men need for comfort and progress is to have a brain that naturally thinks of the work.

1

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ILLUSTRATIONS
OF THE
HARTNESS FLAT TURRET LATHE





1858



1855



1870



1882



1900



1850



1904



1909



1855—The first turret machine having mechanism for automatically turning the turret.

1858—The present form of high turret with substantially the turret-turning mechanism now in universal use.

1870—One of the links in the chain of evolution, showing an automatic chuck.

1882—The first clutch back-geared machine.

1886—The same scheme in more symmetrical form.

1890—The first revolving roller feed.

1891—The first Flat Turret Lathe.

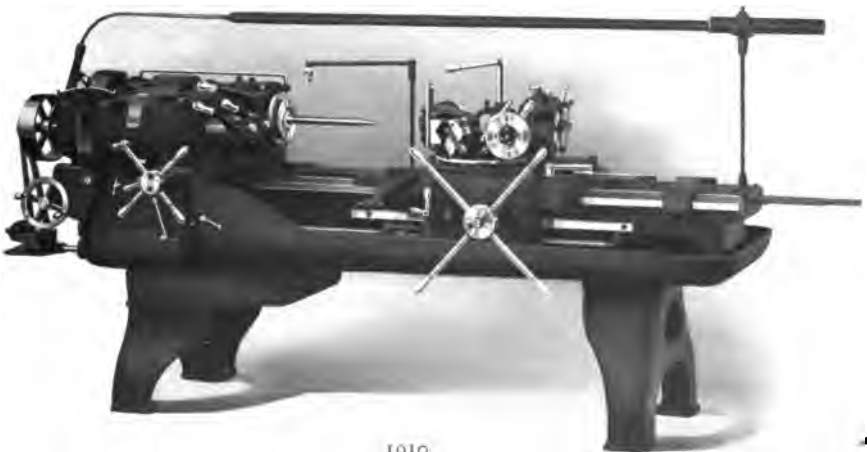
1891—The first quick-opening turner.

1896—Equipped with the lead controlling screw-cutting die.

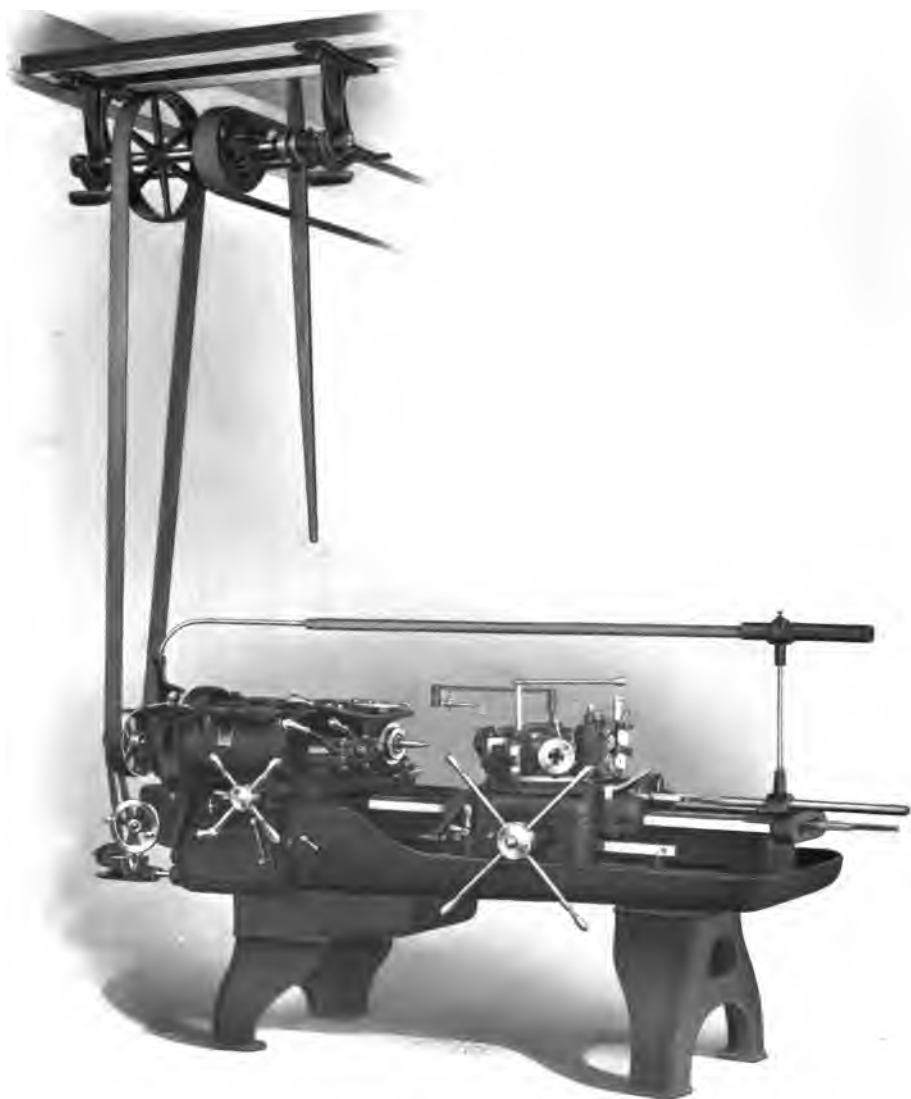
1904—The first Flat Turret Lathe with cross sliding head.

1906—Equipped with the turret chasing tool.

1909—Equipped with chip-breaking turner.



HARTNESS FLAT TURRET LATHE



2 x 24-inch Flat Turret Lathe with Cross Sliding Head, Equipped for Bar Work
(Countershaft Drive)

THE 2 X 24 EQUIPPED FOR BAR WORK



2 x 24-inch Flat Turret Lathe, with Cross Sliding Head, Equipped for Bar Work (Motor Drive)

The Hartness Flat Turret Lathe with cross sliding head is made in two sizes, and may be furnished with an equipment of tools for either bar work or chuck work, or a double equipment for both bar and chuck work.

The smaller machine, shown above and on preceding page, is called the 2 x 24-inch, and when equipped with the automatic die outfit of tools it turns nearly every conceivable shape under dimension of $2\frac{1}{4}$ inches diameter and 24 inches of length. The hole through the spindle is now made $2\frac{3}{8}$ inches. For various details of working range and outfit for bar work, see pages 74 to 112. Itemized outfit, pages 174 and 175.

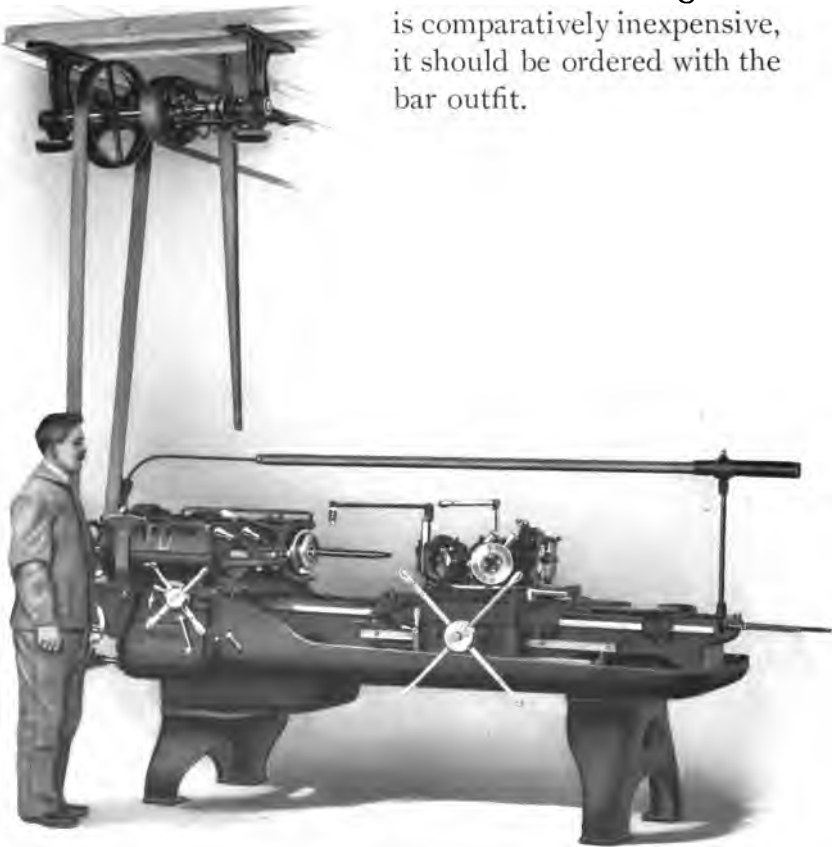
This machine, equipped for chuck work, is described on pages 113 to 159. See also pages 74 to 82.

The machine may be ordered with either the chucking or bar outfit, and supplied later with the other outfit, if for any reason the machine should be changed from bar to chuck work or *vice versa*. Since the chucking outfit is comparatively inexpensive, it is frequently ordered with the bar outfit of one or more machines of a lot, so that at least one machine may be used on short notice for chuck work.

HARTNESS FLAT TURRET LATHE

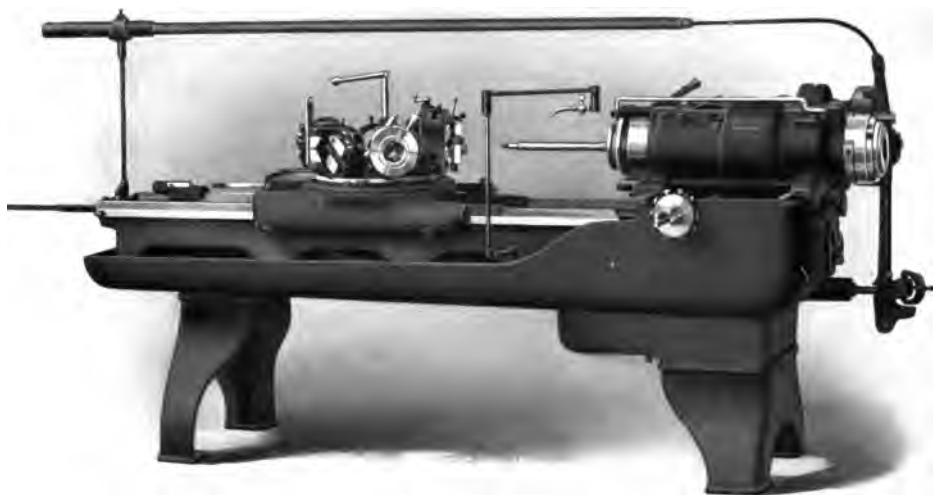
The machine shown on this and opposite page is the 3 x 36-inch size. It is shown in these three views arranged to handle full bars of stock up to 3 inches in diameter, turning pieces up to 36 inches in length, of the class of work shown on the following pages. It may also be equipped for chuck work up to 14 inches in diameter, and is illustrated and described as a chucking machine on pages 113 to 159. Itemized outfits on pages 175, 176 and 177. This machine may be ordered with either the chucking or bar-working outfit of tools, and supplied later with the other outfit.

Since the chucking outfit is comparatively inexpensive, it should be ordered with the bar outfit.



3 x 36-inch Flat Turret Lathe with Cross Sliding Head, Equipped for Bar Work

THE 3 X 36 WITH BAR WORK EQUIPMENT



3 x 36-inch Flat Turret Lathe with Cross Sliding Head, Equipped for Bar Work

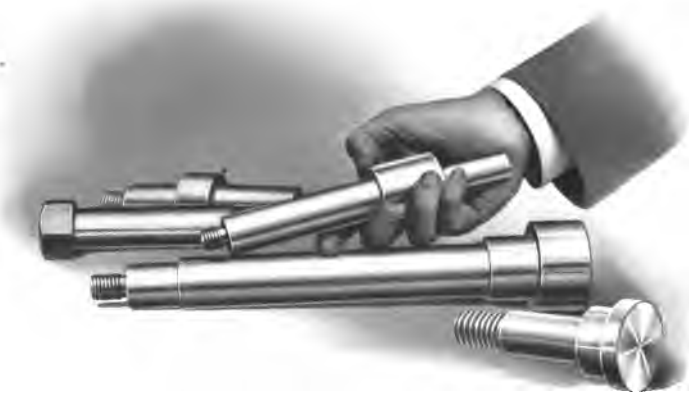


3 x 36-inch Lathe with Motor Drive. (It may be driven from countershaft above if desired)

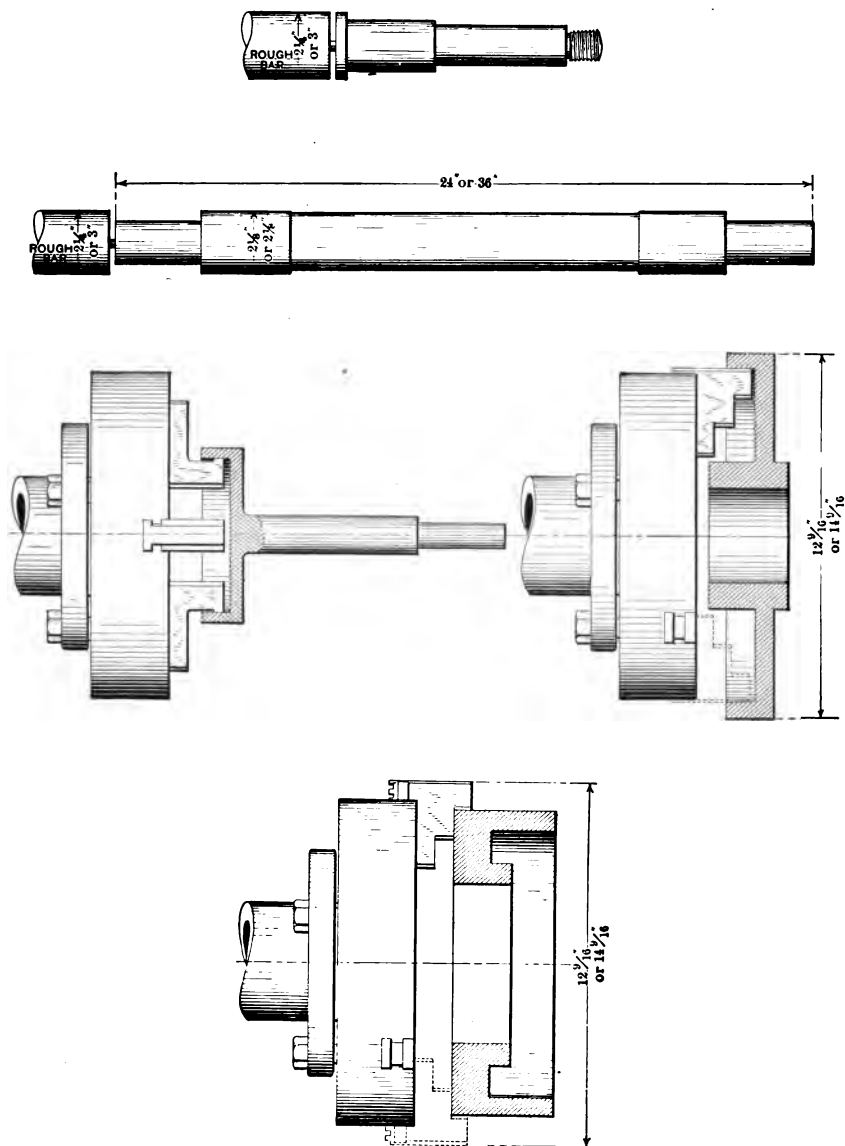
WORKING RANGE FOR BAR WORK

The work shown on this and the opposite page is the product of the Flat Turret Lathe with the automatic die outfit (outfit D). This outfit gives the highest efficiency on such work. In the 2 x 24 machine it turns all diameters up to $2\frac{1}{4}$ inches, and all lengths up to 24 inches, and cuts all U. S. standard screws from $\frac{3}{8}$ to $1\frac{1}{4}$ inches, inclusive, by sixteenths. (Whitworth, Metric or V standard furnished if desired.) Items of outfits on pages 174 and 175.

The same kind of work is turned out by the 3 x 36 machine with automatic die outfit; diameters from 3 inches down, and lengths up to 36 inches, and cutting screw threads from 1 to 2 inches, inclusive, U. S. standard. (Whitworth, Metric or V standard furnished if desired.) Items of outfits on pages 176 and 177.



WORKING RANGE FOR BAR WORK



Examples indicating working range and character of work covered by both machines. (For chucking range and thread chasing, see pages 113 to 159)

MULTI-STOP AND DOUBLE TURNERS

Fig. 1 illustrates the advantage of the *double stop* for each position of the turret, and the multi-adjustment of each turner. This piece has six finished diameters and six shoulders, and is turned by only two turners, which, of course, occupy only two positions on the turret. This not only leaves the remaining positions free for other tools, but it saves the operator the time and energy required to run the turret slide back each time.

All this is obtained without complication, and without introducing any features that are annoying when not in use.

In addition to the double stop for each of the six positions of the turret, we have an extra stop, consisting of a pin which may be dropped into any one of the six



Fig. 1

holes at the rear of turret slide. This makes it possible to borrow five extra stops for any one of the tools, and gives to this tool seven length or shoulder stops, and leaves one stop for each of the remaining tools.

The illustrations, Figs. 2 and 3, give examples of what one tool can do in this machine on chuck work, when we take advantage of the seven length stops and the seven shoulder stops of the cross-feed head.

Of course, in general practice three or four stops for one tool are all that will be needed, but since the modern cutting steels have greater durability, there is nothing lost by giving each tool all the work it can do.

Outer face and all shoulders and diameters accurately finished to independent stops by one tool. When roughing and finishing cuts are required, the roughing tool can be set near enough to use the same stops that are

MULTI-STOP AND DOUBLE TURNERS

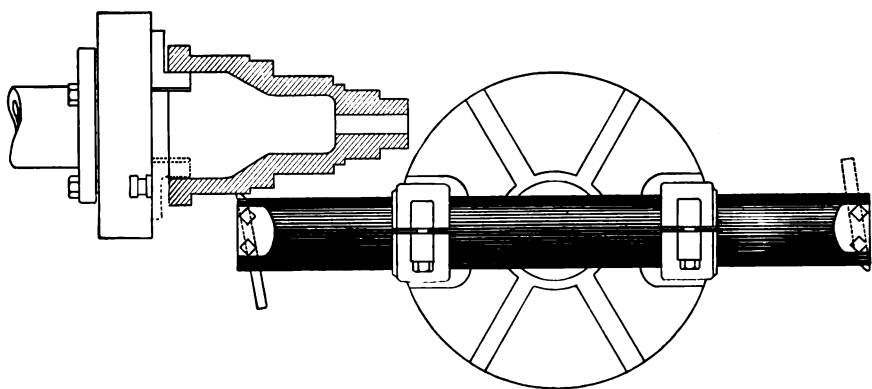


Fig. 2

accurately set for the finishing tool. When an extra tool is used to give a roughing cut it is set as indicated by dotted lines in Figs. 2 and 3.

We find it difficult to illustrate all of the classes of work that can be turned out by this machine, but a little thought will suggest many forms that may be readily handled in bar and chucking work, both steel and iron, on account of the many provisions for bringing both turret and cross slide up to fixed stops, either by power feed or by hand.

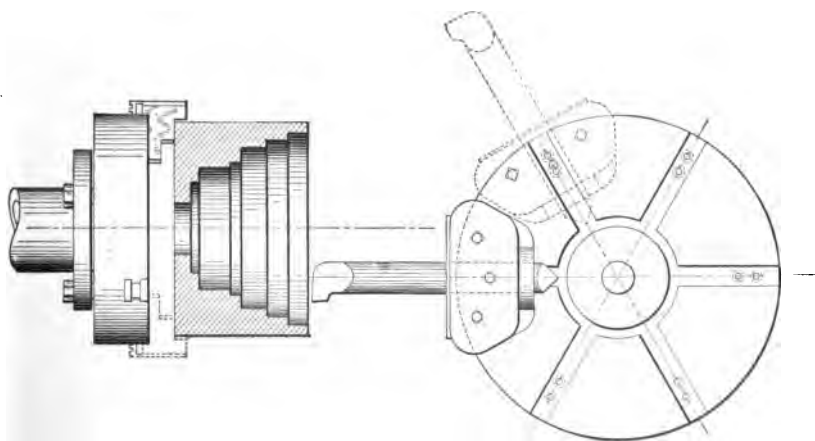


Fig. 3

TURRET DESCRIPTION

The turret is a flat circular plate ; it is mounted on a low carriage containing controlling mechanism. The connections of the turret to the carriage, and the carriage to the lathe bed, are the most direct and rigid, affording absolute control of the cutting tools. The turret is accurately surfaced to its seat on the carriage by scraping, and securely held down on that seat by an annular gib. In the same manner the carriage is fitted to the Vs of the bed ; the gibs pass under the outside edge of the bed.

The index pin is located directly under the working tool and so close to it that there can be no lost motion between the tool and the locking pin. The turret is turned automatically to each position the instant the tool clears the work on its backward travel, and it is so arranged that by raising and lowering trip screws near the center of the turret, it may be turned to three, four or five of the six places without making any other stops.

A simple, accurate stop mechanism for the turret slide provides twelve independently adjustable stops, two for each of the six positions of the turret, or any other division required by the operator.

The *feeding mechanism* for the turret slide and the cross-feeding head receives its power through a speed-varying device which is under the convenient control of the hand wheel at head end of bed. One revolution of this wheel gives the full range of feeds, from drilling feed of 100-per-inch to coarse turning feed of 10-per-inch, and every intermediate feed.

A spring torc weighing device on the feed rod gives the pulling power of this feed mechanism a known value. This device yields at a certain predetermined pressure.

In operation the carriage is fed forward until it reaches one of the stops, against which it is held by this pressure till disengaged by the operator. Arresting the

TURRET DESCRIPTION

feed without releasing the carriage gives the tool a chance to accurately face the shoulder, leaving a smooth surface instead of the ragged face left when carriage is released under full cut.

It has been the practice heretofore to arrange the positive stop a thirty-second of an inch beyond the knock-off for the feed, and in the usual operation of a machine of this kind the feed knocks off, and then the turret slide, released, jumps back, and the tool digs in, cutting a slight groove just back of the shoulder. When on work requiring exact shoulder distances or smoothly-finished shoulders, the operator brings the slide against the positive stop, holding it there with as nearly as possible uniform pressure until the turner has surely faced its full length. In the present machine the turret is always fed against the positive stop and held there with a uniform pressure, insuring the most accurate results for shoulder length.





CROSS SLIDING HEAD

The distinctive feature of the original Flat Turret Lathe was the flat, plate-shaped tool holder from which the lathe took its name. The original work-holding head-stock possessed many distinctive features, such as the automatic chuck and roller feed, but it contained the now nearly obsolete cone pulley drive and back gear scheme. In the present machine we have combined an ideal scheme of speed regulation with many other desirable features.

The cross-feeding feature of the head grew out of our desire to get the best form of self-contained speed variator. After trying several combinations and positions, we found it best to arrange all the shafting and gearing in a horizontal plane, so that the lower half of

CROSS SLIDING HEAD

these running parts could be *submerged in oil* to insure perfect lubrication.

This determined the adoption of a shallow pan-shaped frame for the headstock, into which were placed all the clutches and bearings, including main spindle bearings. The natural form of bed for holding this headstock made the way open to give the headstock a cross travel, which we had long realized was a most desirable feature, as shown by our earlier patents.

A most fortunate combination was the result. We not only obtained a most compact and symmetrical machine, but in one machine we succeeded in getting practically all of the features made desirable by present-day conditions.

The sliding headstock is securely gibbed to guideways running across the machine, thus giving the work-carrying spindle a cross feed relative to the turret, or, in



other words, providing a cross feed for each tool. The value of this feature is not only for chuck work, but for many other kinds of work.

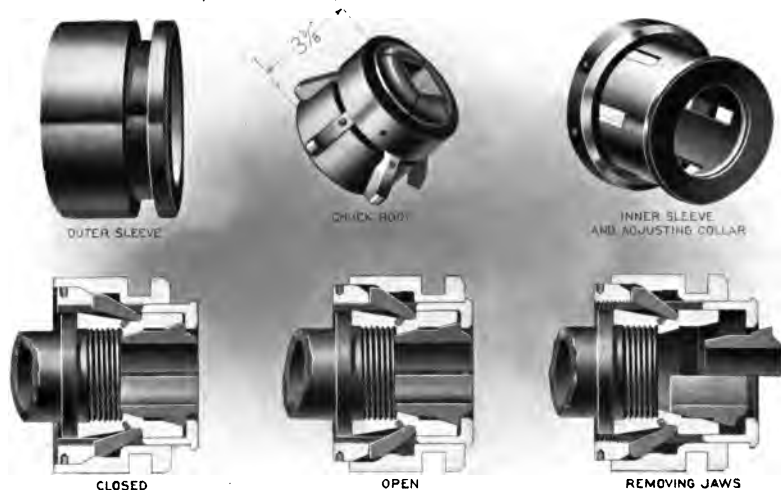
The single drive receives power at a constant speed and in one direction, and all of the changes for variation and direction of speed are obtained by clutches and gears between the power-receiving shaft and the spindle.

Since the pulley receiving the power is driven at a constant speed, it may be belted to *countershaft* above or to a constant-speed electric *motor*. No controller is necessary, only a starting box, and since we do not vary the motor speed, it is not necessary to provide a motor four times the nominal size to compensate for loss of power due to reduced speed. Since we use belt connection, any kind of motor may be used, thus avoiding the delay incident to getting a given type of motor.

The *new high-speed* steels tax the running bearings of a machine to their limit, and to meet this we have used bronze bearings for the driving shafts, and all of these bearings get a continual shower of oil when running, for they are enclosed in the chamber formed by the shallow pan-shaped headstock and its lid.

The cross sliding head is provided with *ten stops* carried in a revolving holder, which is turned at will by the operator. These stops positively arrest the travel of the head. The power feed mechanism feeds the head till it reaches one of these stops and then holds it there against the stop till released by hand. The feeding pressure which is exerted against the stop is always the same. In order to get the same uniformity when the head is moved against the stop by hand there is provided a sensitive indicator which shows the operator when he has exerted sufficient force.

CHUCK FOR BAR WORK



AUTOMATIC CHUCK FOR BAR WORK

The automatic chuck and roller feed handle the rough bars of round, square, octagon, hexagon and flat stock, presenting a new length and gripping it while the machine is running.

The automatic chuck is one of the essential features of the machine in its equipment for turning work from full lengths of bars. Its strong and unyielding grip gives a rigid presentation of the work, which is of paramount importance. The jaws are of unbreakable form and may be readily made for any size or shape of material within the spindle's capacity. All sizes, from $2\frac{1}{4}$ -inch down to $\frac{1}{2}$ -inch in the 2 x 24-inch machine, and from 3-inch down to 1-inch in the 3 x 36-inch machine, and any of the above-mentioned shapes, may be held by the jaws furnished in automatic die outfits of tools.

Special attention is called to the superior construction of this chuck for handling rough bars of stock.

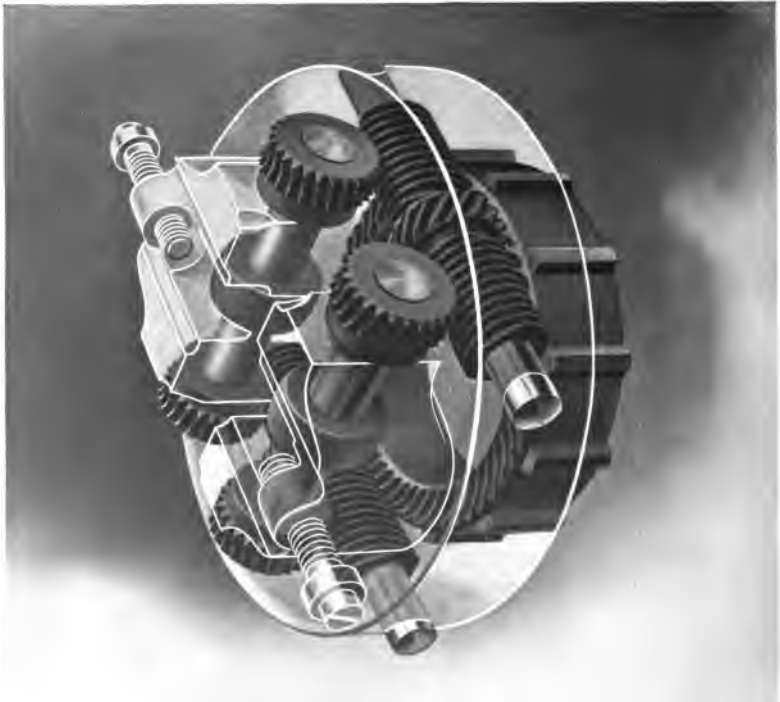
This chuck is used in connection with the roller feed, which is described on the following page.

ROLLER FEED FOR BAR WORK

The roller feed is used in connection with the automatic chuck for the purpose of feeding the bar of work through the chuck while the lathe is running. This of course is only in operation when the chuck is open and is solely for the purpose of presenting a new length of work.

The lever that opens the chuck also actuates the plunger that starts the feeding motion of the rolls.

The roller feed shell is securely affixed to the end of the spindle and of course revolves with the spindle and the work. The outer end of the roller feed is provided with scroll chuck for holding the bar of stock in central position in the spindle.



Roller Feed

ROLLER FEED FOR BAR WORK



Roller Feed

The rolls are held in roll carriers which provide a bearing on each side of the rolls.

The driving gears are double, there being a worm gear on each end of each roll shaft; these, in turn, are driven by four worms, the mounting being so arranged that the work is equalized between each member.

The roller feed is the outgrowth of the original revolving roller feed which we introduced in 1889; the present scheme of gearing has been in continuous use since 1890; the only changes have been those resulting from long use and natural evolution.

This is not only the original but it is the only one that has been continuously manufactured for any considerable number of years.



CROSS SLIDE AND TOOL HOLDER

The turret cross slide is made very compact. The sliding tool block is closely fitted and gibbed to the base, which is bolted securely to the turret. A long lever and a small pinion furnish means for feeding the cross slide tools. The sliding surface is so close to the work that its slight necessary amount of looseness is never greater at the tool point.

This slide is used as a cut-off, also for holding broad tool, especially when the latter is to be used near the outer end of a long and slender piece. For such broad tool work on a slender shaft a supporting bushing is fitted to the hole in upright.

The tool holder furnishes convenient means for holding drill chucks, reamers, taps, etc.

TURNING TOOLS



Turner B

TURNING TOOLS

One turner of this kind in each outfit D for bar work. Turner B has the full working range of the machine and may be used on sizes down to $\frac{3}{8}$ -inch or less. The roller back rest and chip-breaking turners do not go below $\frac{5}{8}$ -inch.

Turner B is not a high-speed turner for it has no anti-friction back rest; it is, however, a desirable addition to the outfit on account of its general adaptability for unusual conditions.

It is provided with a double adjustment for both the cutter and back rest, but it has lost none of its original convenience and simplicity, and may now be used for turning only one diameter without any inconvenience from extra adjustments.

We retain our means for quickly withdrawing the cutter and back rest so that the turner can pass over a large diameter.

HARTNESS FLAT TURRET LATHE

The cutter is rough 1-inch by $\frac{1}{2}$ -inch high-speed steel, is held in the pivoted tool block of forged steel, which in turn is accurately fitted to the hollow frame.

The adjustment of the cutter is effected by two screws arranged side-by-side. These screws take bearing against cams on cam-shaft, which is controlled by a handle similar to that used in a machinist's bench vise. These cams are diametrically opposite, so that either may be brought into action by a half turn of the handle.

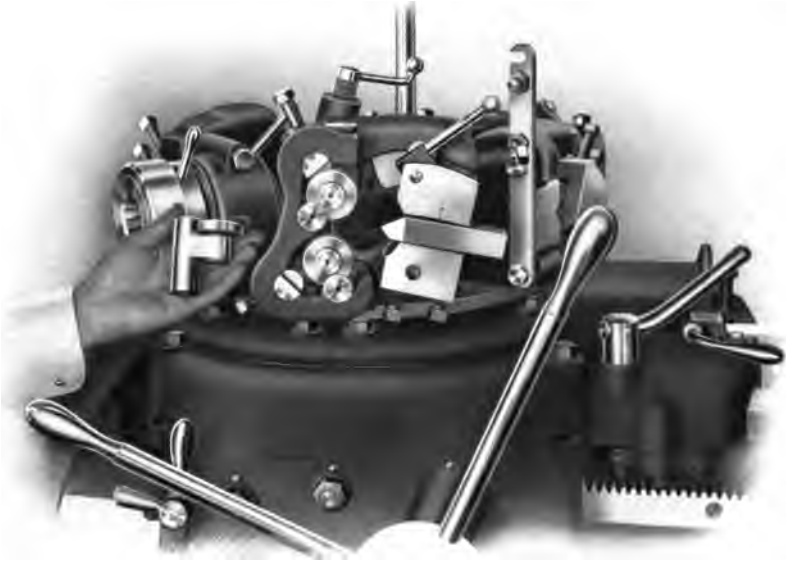
The back rests are controlled by a double latch in order to obtain the double adjustment.

The hollow frame serves as a conduit for the oil which enters the base of the frame through the turret. The oblong opening in the frame over the cutting tool delivers a large, slowly-moving stream of oil directly on the cutting edge.



Bar Work

ROLLER TURNER



Roller Turner, Model H

ROLLER TURNER

The roller turner is provided with roller back rest instead of the V back rest used in the regular turner.

One of these turners is furnished with each machine equipped with outfit for bar work (outfit D).

It has two independent adjustments for turning two sizes.

It may be quickly opened to pass over a large diameter and instantly closed to either of the two sizes for which it has been set.

The rolls may be set to precede or follow the cutter.

It turns either to or from the chuck.

Its rolls run on straight headless pins hardened and ground. These pins are held by a rocker insuring an axis in parallelism with work.

All adjustments are conveniently made and are the most direct and unyielding in resistance of working strains.



Characteristic Chips (about double size). Chips at the left made by diamond point tool having 70 degrees cutting angle. Chips at the right made by no-clearance tool, 45 degrees cutting angle

WORK OF CHIP BREAKING TURNER



Illustrating the work of the chip breaking turner. The six groups of short chips were produced by the chip breaking turner.
The fine, curling chips were not run through the breaker

HARTNESS FLAT TURRET LATHE



Front View of Turner

TURNER K WITH CHIP BREAKING CAP

The chip breaking turner marked a departure from the beaten paths of turner design. Briefly, its features are:

A round-bottomed cutter that swivels so as to get the ideal position of the extreme edge in the metal.

This cutter can be adjusted to cut without clearance or an exceedingly small angle of clearance.

The cutter requires very little grinding to sharpen its edge.

A dull cutter can be quickly and accurately replaced by a sharp one.

CHIP BREAKING TURNER



Turner adjusted to large diameter of work



Turner adjusted to small diameter of work

HARTNESS FLAT TURRET LATHE



Back view from back of machine (turner)

Adjustments are provided by which the turner may be set to turn four different diameters on each piece of work.

In other words, it is equivalent to four turners without occupying four turret positions.

A compensator provides a means for offsetting slight wear of tool point and slight difference in size produced by putting in a newly sharpened cutter.

The rolls in roller backs take a flat face contact on work instead of the usual periphery or wheel-like bearing. These end thrust rolls present a most unyielding support for the work.

CHIP BREAKING TURNER



Back Rests

Each of these features has an important effect on the quality and quantity of output, but perhaps the clearance control is of greatest interest.

Heretofore all turning and planing tools have been given clearance. Notwithstanding the steady advance along all other lines of design there has been no change in the real position of the extreme edge of a cutting tool in the metal.

All tools have been tipped up so as to scrape off the chip. This position of the cutting edge in the metal has been considered necessary. The angle at which the under-face stands away from the work from which the chip is scraped is called "clearance angle." It has varied from 15 down to 3 or 4 degrees, with the average practice of about 8 or 10 degrees.

All shapes of tool noses from the round nose to the sharp-cornered side tool have been made, yet in all these tools the real working condition of the edge in the metal has not been changed. The tool has always taken its stress wholly one-sided. The chip has borne on one side of the edge, and the edge has had no support or

corresponding pressure from the other side; therefore it has had to be made of sufficient lateral strength to withstand this one-sided stress.

This has made it necessary to abandon acute edges such as would be naturally chosen for cutting.

In designing the present turner, an effort was made to "get back to nature" by considering the stresses and conditions at the extreme edge.

This attempt resulted in the following conclusions:

The blunt edge tools of standard practice (70 degrees cutting angle) should only be used for turning cast-iron and for rough-turning steel.

For turret lathe bar work the best results can be obtained by a tool having a real cutting or wedge shape edge — one that actually cuts and plows the chip away from the stock.

The wedge-like cutting edge should be allowed to act like a wedge; that is, to ride on the surface of the metal from which the chip was being lifted and wedged away.

By allowing the under-face of the edge to ride on the surface of the work, it is supported directly under the chip stress. Thus the cutting edge is relieved of the one-sided stress to which it is subjected when set in the orthodox "clearance" or scraping position.

TROUBLESOME CHIPS

The lathe hand dislikes a stringy, curling mass of chips almost as much as he dreads the perpetual menace of the fire-balls thrown off by blunt tools at high speeds.

The curling, continuous chips are sometimes used to illustrate the ideal cutting condition, but they make just one impression on the lathe hand who has encountered them at the high cutting speed.

The illustration of a turner or a lathe with one or two beautiful curls of chip arranged in wreath or scroll

CHIP BREAKING TURNER

may be pleasing to the artist's eye, but it is a reminder of trouble to the lathe hand.

A picture of the same turner or machine under the one mile's length of beautiful chips (which would be produced in one or two hours' time at 100 or 50 feet per minute) would not be so pretty, but it would be truer to life.

THE "SHARPEGE" CUTTER

The chip-breaking turner uses a cutter having an acute edge. It is a knife-like blade that is always ground to certain fixed angles. No special talent or special facilities are required for grinding it, but it should always be ground to directions found on pages 110 to 112 to insure the best results both as to speed and quick change of cutters.

A machine-formed cutter has been adopted in preference to the rough steel cutter of other turners—the object being to get the advantage of quick reset and least grinding.

Heretofore the machine-formed cutters have only been used in inadaptable holders and were run at slow speeds to save trouble of renewal.

The rough bar steel cutter, which is so dear to the hearts of most of us, requires much grinding for sharpening, and it cannot be quickly reset with the precision necessary for satisfactory duplication.

THE SWIVEL MOUNTING

The present cutter has a round bottom which allows it to swing around a few degrees so as to allow its underface to ride flatly against the face of the work, and to gradually change its angular position to compensate for an unequal wearing away of the face of the tool. This swinging does not materially change the location of the extreme edge, for the cutter swings on a center line

that follows nearly the line of the edge. Therefore, the depth of the cut and the advance of the edge in cutting are both under absolute control, while the cutter is more or less free to swing to any angle that may be necessary to insure an ideal position of the extreme edge in the metal.

The tool has been called a non-clearance tool, but it would perhaps be more fitting to call it a no-negative-clearance. It will cut without clearance, with its face rubbing flatly against the shoulder from which the chip is being taken, or it may be set to cut with extremely slight clearance.

The tendency of the cutter is to swing into the no-clearance position, but the stress of cut usually holds it in its seat wherever it happens to stand in beginning the cut. But if there is an excessive rubbing contact on the so-called clearance face, the tool swings slightly to relieve this stress.

This allowing the cutting edge to take bearing on each side of its face—which in reality is the condition when it is cutting with extremely slight clearance or no-clearance—has made it possible to use more acute cutting edges than heretofore, for it has greatly reduced or wholly balanced the one-sided stress of the orthodox tool, and it has wholly eliminated the quivering incident to forming the chips under the usual intermittent flow.

CHIP BREAKING

Probably the use of sharp edges for very soft steels would have been more general if it had not been for the already-mentioned troublesome nature of the chips.

Long, curling and wirelike chips are a torment to the average man. The sharp cutter of the chip-breaking turner produces a very tough chip, but the chip passes

CHIP BREAKING TURNER

directly into a diverter or controller. This diverter breaks all ordinary chips into short pieces.

The chip produced is a flat or slightly curved chip which occupies very little space.

Thus the two barriers to the use of a sharp tool have been removed. The thin edge has been made durable by allowing it to ride on the metal from which it is cutting the chip, thus eliminating the destructive one-sided pressure and lateral quivering, and the tough chip is no longer troublesome because it is now broken into short lengths.

LEAST GRINDING AND NO FORGING

The cutter used in this turner requires no reforging, and since it is comparatively slender it requires very little grinding for maintaining its edge. The shape of its cutting end is always ground the same, with the exception that the top slope may be varied from 55 down to 45 degrees of cutting angle, but for best results on average work with 50-degree top slope.

QUICK RESETTING

The cutter is always set in its holder against a locating stop, so that a dull tool may be quickly and accurately replaced by a sharp tool, with minimum effect on the size produced. The locating stop makes the new tool take the position of the preceding cutter with a very slight error.

A compensator is provided to quickly and nicely offset any slight error.

MULTI-SIZE ADJUSTMENTS

One of the distinctive characteristics of all of the Flat Turret Lathe turners is their multi-adjustment, by which each turner can be used for more than one size. Previous types (Nos. *B* and *H*) are provided with adjustment that

may be set for producing two sizes while the present turner may be used for four different sizes.

It is therefore almost a turret in itself. The extra adjustments are of such simple nature that they add no expense to the first cost and are not in the way if not required by the work. The advantage, however, of the quadruple size turning turner will be readily recognized.

The compensator previously mentioned is a valuable adjunct to the multi-size producing scheme, for it is obvious that a slight wear of the tool point, as well as a failure to accurately return the sharp tool to the previous position of a dull tool, would necessitate the readjustment of the four adjusting screws in the absence of this auxiliary adjustment.

The importance of quick resetting, minimum grind and no forging will be realized when we remember that we run a cutting tool as fast as we can consistently with the time lost in exchanging and sharpening cutters and in restoring a new tool in the exact position of an old one without loss of size.

The quick reset to exact position, therefore, becomes the means for making higher cutting speeds practical in actual work.

It does not increase the cutting speed for a stunt performance on one piece of work, but it does increase the actual running speed and output.

BACK RESTS

The back rests are also unique — they present nearly a flat face to the work instead of the usual wheel peripheral contact of former roller back rest.

The face rolls and holders present a strong resistance to the cutting stresses, and are practically unyielding in this respect; and, last but not least, they lend themselves admirably to the multi-size adjusting features.

CHIP BREAKING TURNER

HOW TO SET TOOL. In putting in a newly ground cutter, push it firmly against stop pin and then tighten inner clamp by nut on under-side of cutter holder.

The tension on the clamp should be comparatively light. The clamp should be firmly held, but no tighter than can be conveniently set by the very short wrench by hand.

The outer clamp serves to hold the cutter endwise as well as sidewise. This outer clamp is made slidable on the cutter holder so that the pin in it may drop into one of the notches in the top of the cutter for the purpose of holding the tool endwise against the stop pin and to resist the outward stress of cutting.

This outer clamp should be pressed inward as it is being gripped by its binding screw. This holds the pin firmly against the inner side of the notch in the top of the tool so that it is ready to resist any tendency of the work to push the tool outward.

The outward thrust is not as great with this kind of a cutter as with the round nose or blunt edge tools in common use, but it should be firmly and unyieldingly resisted.

The clamp for this purpose is fitted to a rail to which it is gripped by the binding stress, so that although it is free to move when the screw is loose, it becomes fixed endwise when clamped.

The tension of both of these clamps may be varied to suit conditions, but for general practice the tool should be clamped with sufficient firmness to a little more than equal the stress of cutting. The cutting stress alone presses the tool very firmly in its seat, and the additional stress of the clamp only makes for stability of lateral control of the edge without undue restriction on the oscillatory freedom under actual working stress.

The tool should be set with slight clearance when sharp—the oscillatory motion being simply to allow it to swing away from the shoulder of the cut when its edge has worn to the no-clearance condition and is tending toward the negative clearance.

The screw marked “Clearance Control” may be adjusted while running. Do not set the screw up hard. If you wish the tool to work with no clearance, you may adjust it up slowly after the cut has been started. If you adjust it too fast you will get a chip that will be of uneven thickness; that is, the tool will alternately “ride” and “dig.”

There is a nice position for ideal running which may be reached by adjustment, but the better way is to allow the tool to have the extremely slight clearance which its holder naturally gives it, and then let it run till by wear it has lost this clearance and has commenced its proper function by preventing a “Negative” clearance.

ADJUSTMENT OF CUTTING TOOL. The diameter produced by the cutting tool is controlled by the adjusting screws marked “Diameter Adjustments.”

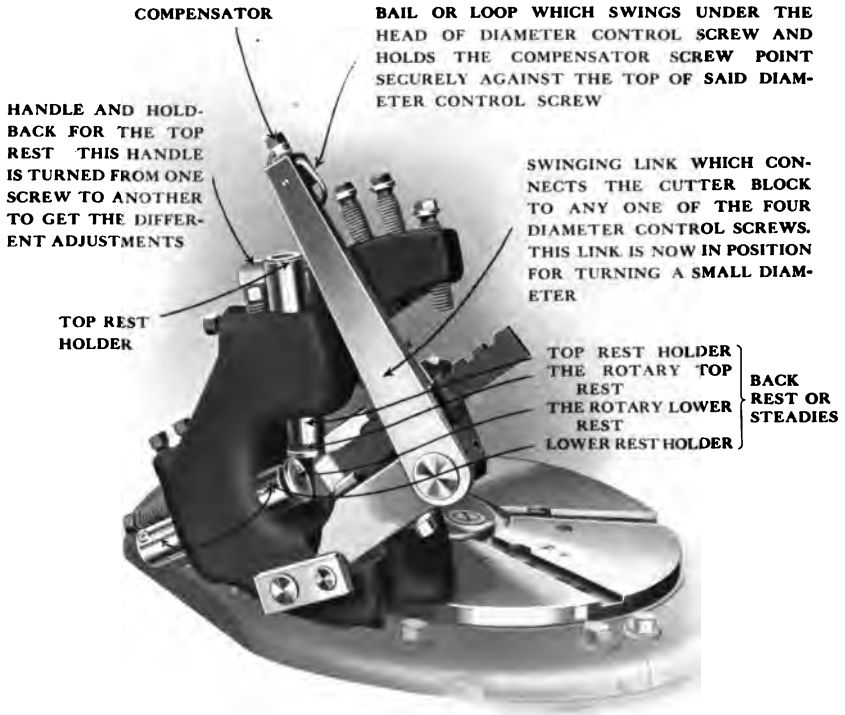
There are four of these screws—one for each diameter to be produced.

In general practice, the turner may be set for only one or two diameters, but if the work needs more cuts than can be taken by the other turret tools, then two or more of these adjustments may be brought into service.

The connecting arm or link is swung from one screw to another as required by the work.

An auxiliary adjustment is provided to compensate for wearing away of the tool point, or change of position of tool point, due to putting in a sharp tool. This adjusting screw is called the compensator, for it furnishes a means for offsetting this slight change.

DIRECTIONS

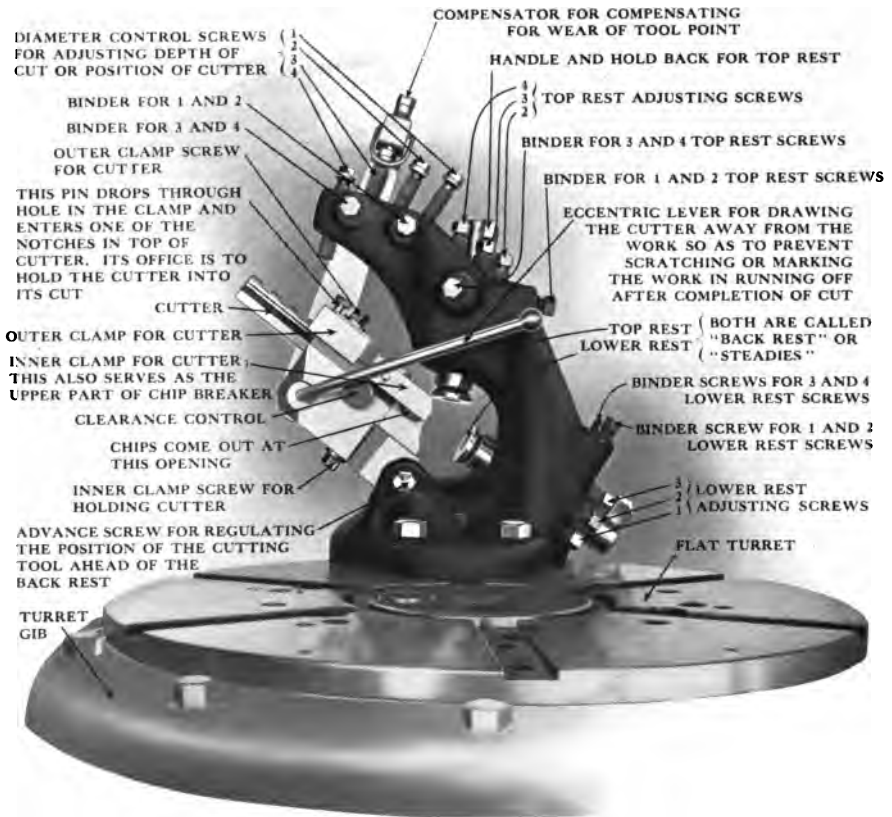


Chip Breaking Turner

The compensator is provided with a pointer that should be moved over from time to time as the tool wears, or as required by the position of a new cutter.

The compensator thus becomes a very convenient means for offsetting changes that would otherwise affect all of the adjustments. Its proper use, combined with care in grinding cutter, with point always exactly $\frac{1}{8}$ -inch high, makes possible the quick resetting; this makes it practical to running higher cutting speeds than would

HARTNESS FLAT TURRET LATHE



Back View of Turner

be practical if the resetting required the usual amount of time and entailed the usual amount of poor or bad work.

THE ADVANCE ADJUSTMENT FOR CUTTER. The cutter should be adjusted to stand a very slight distance in advance of the back rests.

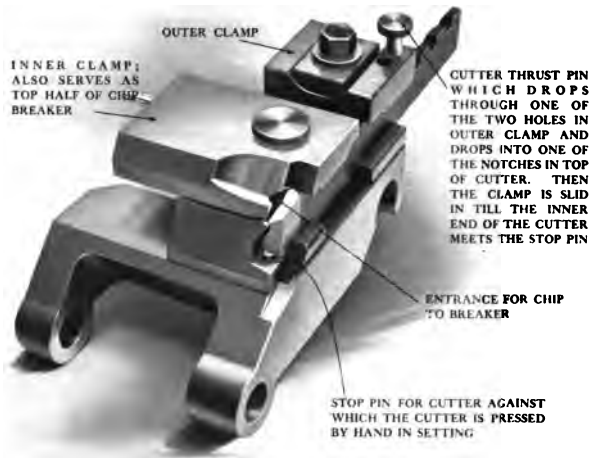
The screw marked "Advance Control" should be adjusted so as to hold the tool only as far ahead of the back rest as necessary.

DIRECTIONS

A good way to effect this adjustment is to gradually let the screw back till the back rests are exceedingly close to the shoulder.

The importance of maintaining the extremely slight advance of cutter ahead of back rests is to get the straight work which comes from this method.

If the work runs rope-like or in bunches, or is extremely crooked, look to this point of cutter advance.



Cutter Block Complete with Both Caps in Place

The correct adjustment of this screw should cure bothropy and bunchy work, and almost all cases of crooked work.

Of course, crooked work may be due to change in metal due to removal of the outer stresses, but it is more often due to faulty adjustment of back rests or to a careless start made by banging the cutter into its work at the beginning of the cut without allowing it to get a true surface turned for its back rests.

The "Advance Control" screw also furnishes a means for setting the tool to follow the back rests when in turning long, slender work it is desirable to have the back rests precede and take bearing on a surface to which the new cut must run true.

This is not often necessary, but when a long piece of slender work runs out a trifle it is frequently desirable to run with the back rests ahead of the tool in order to make the new cut run concentric with the previously-produced surface.

This requirement is brought about when it is necessary to turn the end of a long, slender piece of drawn stock a long distance from the chuck. In all such work the back rests should precede the cutter just far enough to get its full flat contact, which is about $\frac{1}{8}$ -inch ahead of edge.

The one point to remember, the regulating of the advance control screw, is to keep the back rest opposite the cutting stress as nearly as may be. For it will be readily seen that the work will spring away from the tool more under a heavy cut than a light cut, providing the back rests are not directly opposite the stress.

In turning rough bars there is always more or less difference in the depth of cut on opposite side of bar due to the bar running "out."

With the back rest too far away from the position directly opposite the cutting stress, every time the heavy side comes to the tool, the bar springs away, due to the slight bending of the bar, and the canting around of all the yieldable members of the machine. Therefore see to it that the relation of the back rest to the cutter is always properly adjusted by the advance control screw.

THE TENSION OF THE BACK RESTS against the work depends on the cutting stress. If the back rests are not properly adjusted, the work may run tapering.

DIRECTIONS



Cutter Block with Top of Chip Breaker Removed

For instance, in taking a cut $1\frac{1}{2}$ inches in diameter, and say 8 inches long, if the outer end is found to be larger than the part near the chuck, then it is safe to assume that the back rests have not been set up hard enough. On the other hand, if the work is larger at the chuck, the reverse may be true.

The back rests should be adjusted for tension on a true diameter produced near the chuck. Of course, there are instances where this is impossible, but always remember that the tension should be equal to the stress of the cut — this will give the top rest a little greater tension than the lower rest.

The adjustment of the back rests is effected by the screws arranged around each back rest holder.

All adjustment screws are provided with binder screws. In some instances one binder screw clamps two of the adjusting screws. Reference to illustration on page 104 will clearly show the function of each screw and binder.

The cutter holder is seated into the main frame by a knuckle joint, and it is held firmly in this seat by a pin and binder plate on front of the turner.

The eccentric pin has a slotted head that makes it appear like a cheese-head screw but this will not deceive anyone who has once known its function.

The eccentric pin may be turned by a screw-driver till it firmly seats the knuckle of the tool holder into its socket in the frame.

The binder screw for this eccentric pin is under the tool holder in the main casting, and faces the operator when the turner is in working position on the turret.

The binder plate may be removed by releasing the binder screw and by pulling out the eccentric pin.

ECCENTRIC PIN. This pin is under the control of the eccentric lever at the back of the cutter holder.

DIRECTIONS

The connecting arm or link is connected to the cutter holder by an eccentric pin in order to provide a means for preventing the cutter scratching the work in running off after having completed its cut.

The stream of oil or borax water flows through the hollow frame of the turner and emerges from a rectangular slot directly over the cutting edge.



Bar Work. (Pieces made from long bar of stock)

THE "SHARPEDGE" CUTTER

HOW TO GRIND. The best results for quality and quantity of work can only be obtained by care in grinding the cutter.

The cutter should be ground to the gage with a reasonable degree of precision.

The important dimensions are shown in the illustration on page 112.

The height of the nose of the tool should always be the same in order to get the advantage of a quick resetting of the cutter. This height should be $\frac{1}{8}$ -inch for all new lathes. If the center of the spindle is not exactly three or four inches above the top face of the turret, then the height of the tool nose may be made that much more or less.

But always remember it should always be the same for all the cutters used in the lathe. It will be a very old lathe that will require any departure from the $\frac{1}{8}$ -inch height of tool point.

If all tools are ground accurately in this respect, there will be very little delay in exchanging tools for the purpose of getting a sharp tool quickly substituted for a dull tool.

Always grind the cutting edge from the $\frac{1}{8}$ -inch up to the top edge of the tool, making the cutting edge $\frac{5}{8}$ -inch long.

The object of keeping the edge slanting down toward the point is to reduce the end grinding which is necessary to carry the edge back far enough to restore the edge. If this front slope is made less than 18 degrees it only increases the amount of end grinding; and of course a steeper angle, say of 20 degrees, will reduce the amount of grinding. The only objection to the steep angle is that it makes the cutting edge too short for cuts that are deeper than $\frac{1}{2}$ -inch.

DIRECTIONS



The end of the tool should be exactly square with the bottom and the front face. The corner may be rounded a trifle with a hard oil-stone, and in extreme cases may be given some drag, but beware of the troubles of a faulty drag—a very slight change makes a vast difference in surface of work. The square corner, or the one nearest to square, turns the nearest to straight, providing back rests are set close to shoulder.

The sharpness of the edge should not be neglected. The angle should be 50 degrees. It may be as much less as the material will work satisfactorily, but it should not be more than 55 degrees.

The form of the chip breaker makes it necessary to grind the top slope of the tool within certain limits. These may be roughly stated as lying between 45 and 55 degrees.

If the tool is too blunt the chip will curl up and pass over the breaker, and if the tool is too sharp, say below 45 degrees, a stringy chip may cause trouble by going between the cutter and the chip breaker.



Grinding Gage — Full Size

HARTNESS FLAT TURRET LATHE

If the grinding gage should be mislaid, the following illustrations will serve as a guide to grinding. The use of the square and bevel protractor will not be necessary to one accustomed to grinding.



The "Sharpedge" Cutter



This measurement should be $\frac{1}{8}$ -inch



The cutting angle should be 50 degrees, never more than 55 degrees and never less than 45 degrees



Front slope should be about 18 degrees. It may be more, but never less



Grind the nose square to bottom and face

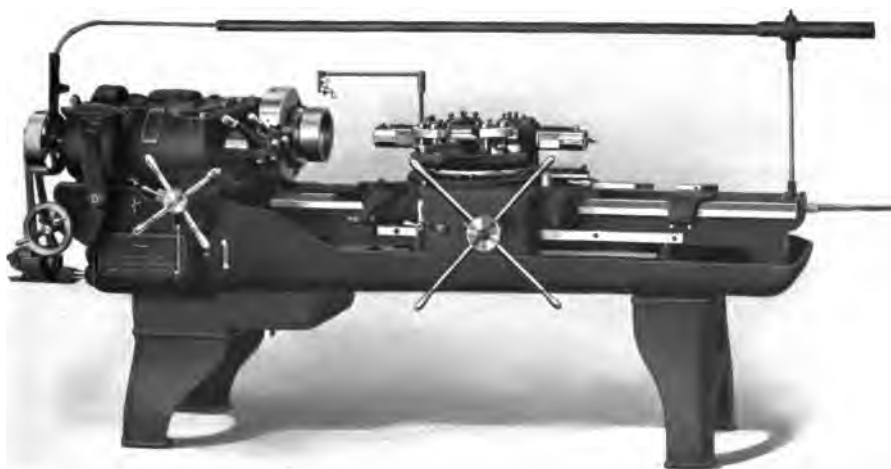


FLAT TURRET CHUCKING LATHE



UST as the original Flat Turret Lathe was equipped with an outfit of conveniently adjustable tools for bar work, so now, with the present machine, we have provided a universal outfit of tools for chuck work.

The many illustrations of chucking tools and conditions under which they work will carry conviction that we have not fallen short of our established record, to use only the most practical and efficient tools, held under the most rigid control, and in



HARTNESS FLAT TURRET LATHE



The Flat Turret Lathe at work, showing the convenience of control and the stability of tool support

conveniently adjustable holders. When we say chuck work, we do not mean merely the process of boring a rough hole in a piece of work to be reamed elsewhere, and after that to have the piece pushed on an arbor and turned in some other machine, but we mean finishing the work shown by our accompanying sketches, in which every possible cut is taken that can be taken, and still leave means for holding the piece.

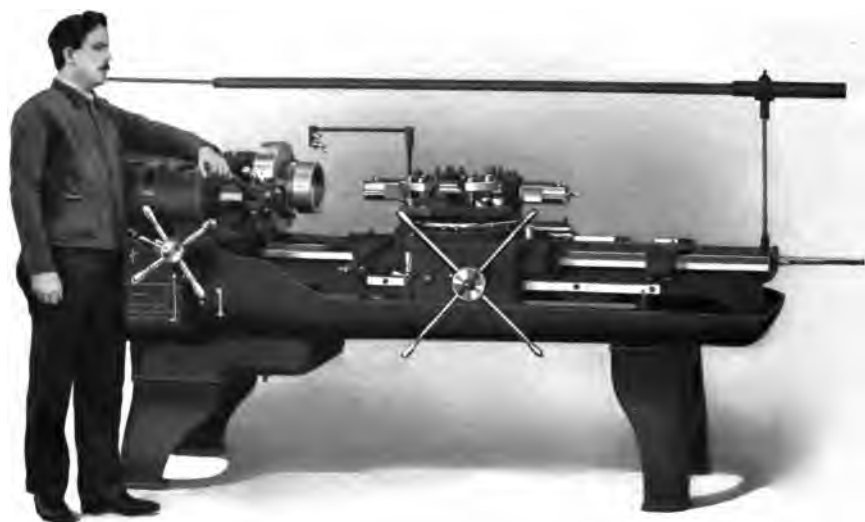
Just as in the past we restricted our working dimensions to a 2-inch spindle hole, so now in this machine we restrict our chucking swing to 12 and 14 inches; but in doing so we furnish a machine that cannot be equaled by any other machine.

The simplicity of our entire scheme makes it possible to retain for our entire range of work our claim made for the original machine, viz., we can make one piece quicker than it is possible to make it in an engine lathe, and if two pieces or more are required, our system of stops makes a convenient and quick means for accurate duplication.

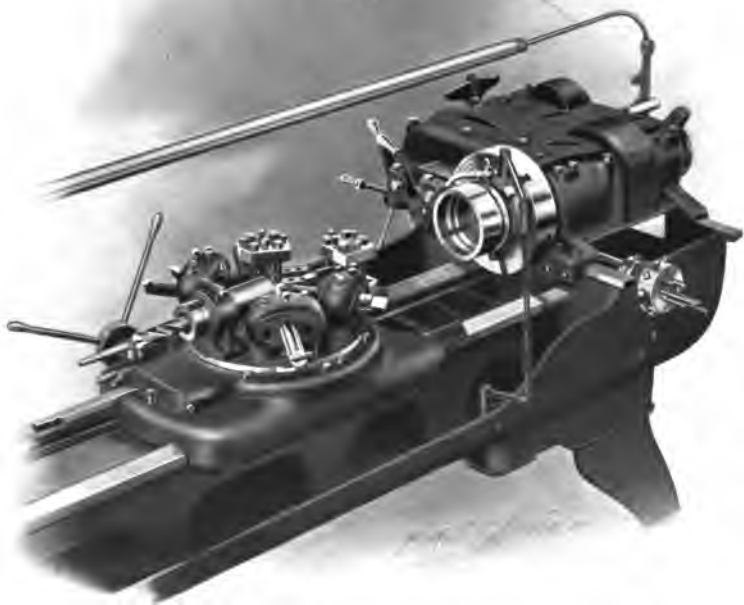
The ten stops for the cross-feed head, combined with the dozen stops for the turret, and the turning and boring tools, all of the simplest and stiffest construction, make this machine ready to begin work as soon as it is supplied with the driving power. It is not only ready to begin work on the work for which it may have been purchased, but it is supplied with a set of tools that will take care of any similar piece any hour or any day in the future; and, notwithstanding this universality, adaptability and efficiency, our tools and work are brought together under the most rigid control and under ideal conditions never before attained in a lathe.

All the shears and running surfaces are protected from the dust of cast-iron, so that the machine may be used for either steel work in which oil is used, or for cast-iron chucking.

HARTNESS FLAT TURRET LATHE



CHUCK WORK



HARTNESS FLAT TURRET LATHE



Showing simple arrangement of tools for producing parts of cone friction clutches, broad tools being used for short taper surfaces. This also shows one method of accurately chucking for second operation—a central plug being used for centering the piece.

CHUCK WORK



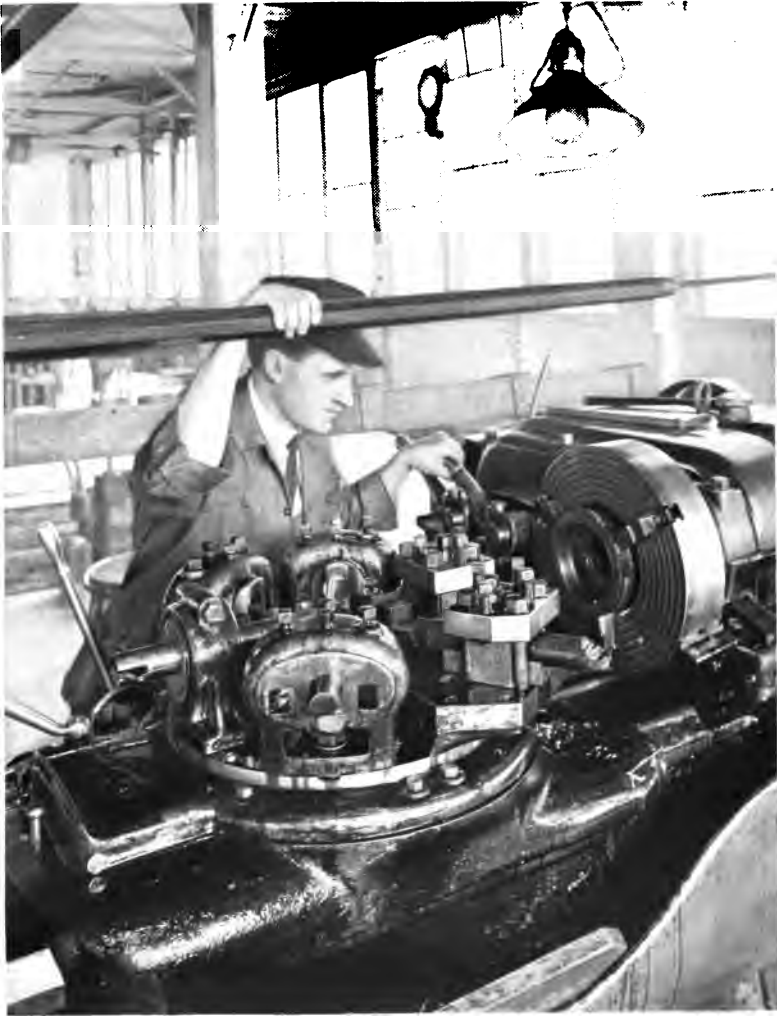
Samples of work for which the machine shown on opposite page is adjusted



HARTNESS FLAT TURRET LATHE



CHUCK WORK



The examples of chuck work, shown on pages 118 to 155, inclusive, indicate the working range of our machine with its standard equipment of tools. With the exception of the chasing attachment, all of the work shown may be accurately and quickly produced with our chucking outfit, and only an occasional extra arbor, or part, that will be readily apparent by looking over the cuts.

AUTOMATIC SCREW CHASING TOOL

The automatic turret chasing tool is for cutting screw threads on chuck work.

It cuts screws of any diameter from $1\frac{1}{2}$ down to $\frac{1}{4}$ inches in diameter for internal screws, and about 1 inch for external threads, and any length under 4 inches.

It consists of a compact tool which is rigidly bolted to the top of the turret.

This tool contains a 2-inch sliding cutter bar and a small lead screw with automatic devices for engaging and disengaging the nut. There is also a small rod which furnishes a rotary connection between main spindle of lathe and the lead screw.

In use the cutter bar carries the cutter or chaser back and forth over the work automatically, while the operator's only duty is to regulate depth of cut by feeding cross sliding head the requisite distance each trip of the tool.

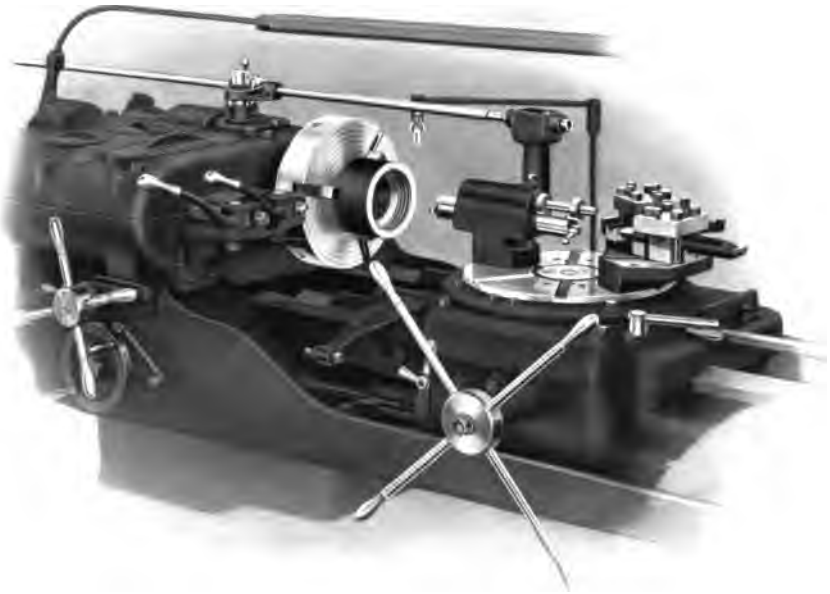
This chasing tool greatly extends the working range of the turret lathe, for it is now possible to include that class of chuck work which was formerly retained by the lathe on account of its having a screw thread.

Much of this work has been distinctly turret lathe work, but on account of the turret lathe having no accurate means of completing all operations, including the screw threading, it has been necessary to have all the work done on the engine lathe.

But now, with this feature, the chuck work with screw threads may have the advantage of the most rapid and accurate scheme of screw cutting, combined with the unflinching tool control and other features for accurate duplication, that may be found in this turret lathe.

An extra lead screw, with nut, is required for each lead, but one set will cut any diameter and either right or left-hand screws.

AUTOMATIC SCREW CHASING



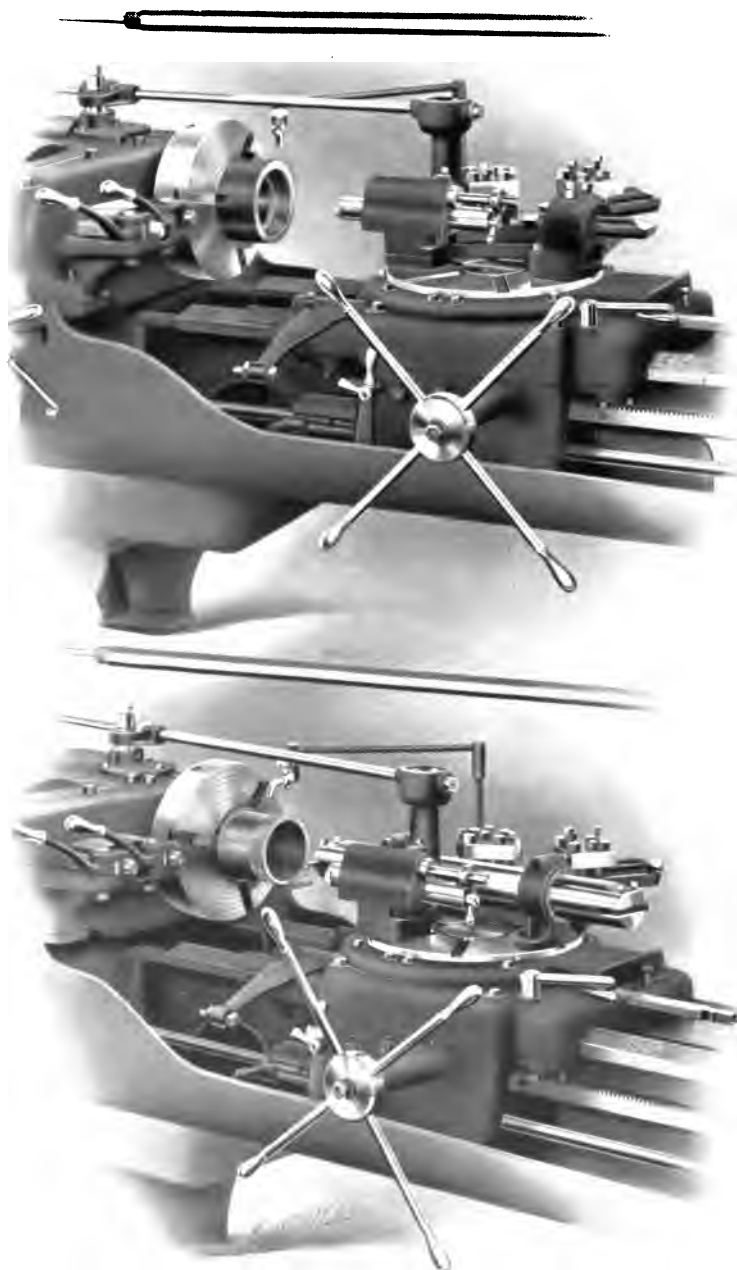
The above cut shows the chasing tool in working operation (some of the other tools have been removed to give a fuller view).

The main casting may be bolted square for parallel screws, or at any angle for taper screws. A removable key fits slot in turret top for holding tool in position for parallel threads.

A chaser-shaped cutter having several cutting teeth is furnished for U. S., V, and Whitworth threads, but we recommend the use of single-point cutters for square and Acme standards; also for all threads that must run full close to a shoulder.

The great advantage of this attachment is in its producing a screw thread which is known to be absolutely true with the other cuts that have been taken at same setting, and, notwithstanding its rapid operation, its accuracy exceeds the product of the average engine lathe.

HARTNESS FLAT TURRET LATHE



AUTOMATIC CHASING TOOL



These three views of the chasing tool show its use for three different kinds of work. In the top picture on opposite page it is cutting an inside screw thread and the lower cut illustrates the tool in position for chasing an outside thread.

HARTNESS FLAT TURRET LATHE



Samples of Chuck Work



CHUCK WORK



Samples of Chuck Work



HARTNESS FLAT TURRET LATHE



Samples of Chuck Work



CHUCK WORK



Samples of Chuck Work



HARTNESS FLAT TURRET LATHE



Samples of Chuck Work



Samples of Bar Work

CHUCK WORK



Samples of Bar Work



Samples of Bar or Chuck Work

HARTNESS FLAT TURRET LATHE



Samples of Chuck Work



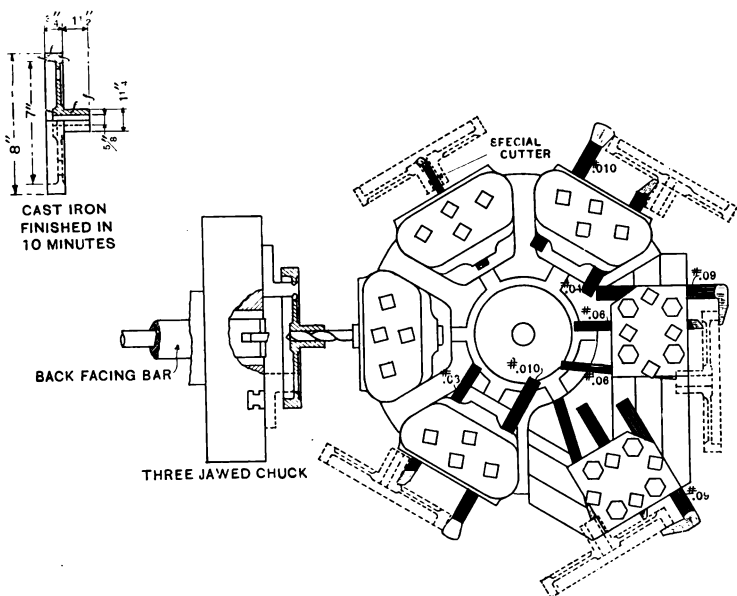
CHUCK WORK



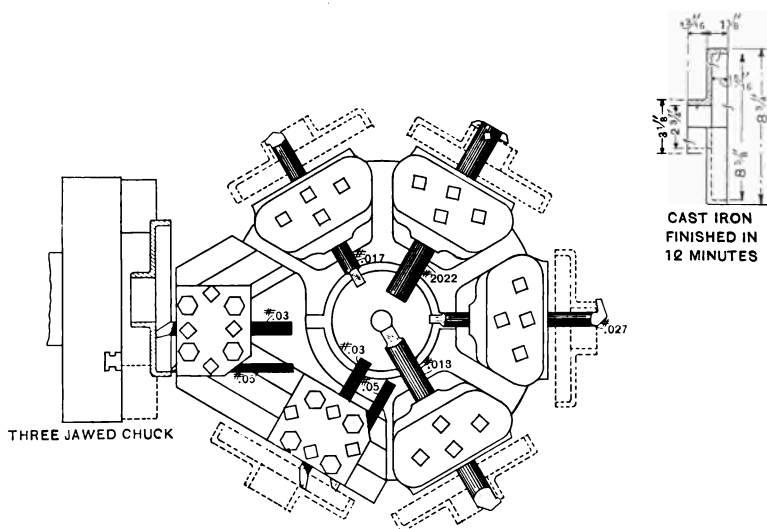
Samples of Chuck Work



HARTNESS FLAT TURRET LATHE

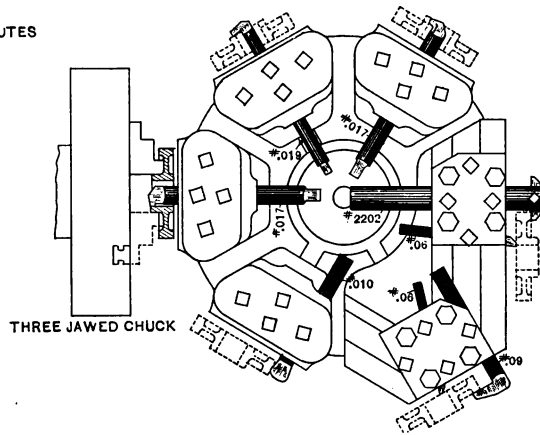
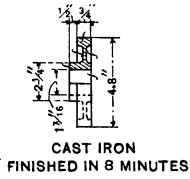


Finished in One Operation

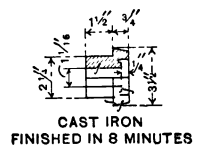
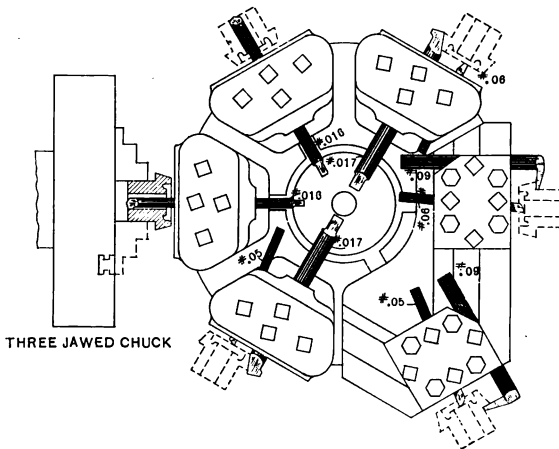


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CHUCK WORK

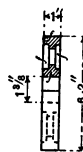


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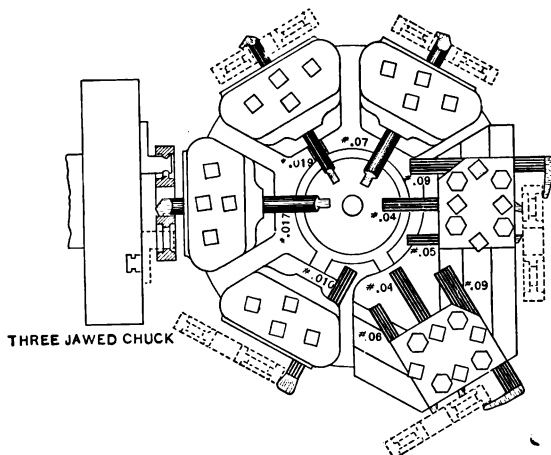


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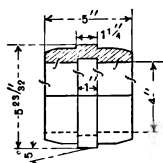
HARTNESS FLAT TURRET LATHE



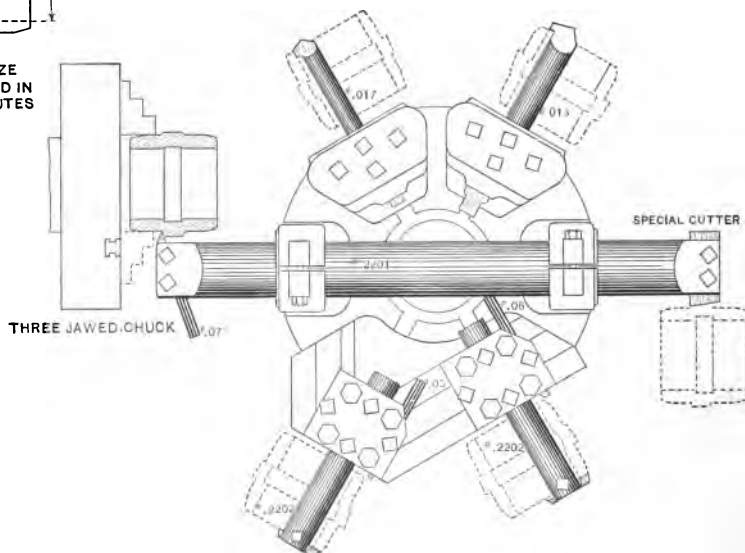
**CAST IRON
FINISHED IN 9 MINUTES**



Finished in One Operation

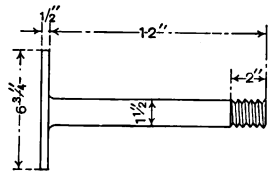


**BRONZE
FINISHED IN
12 MINUTES**

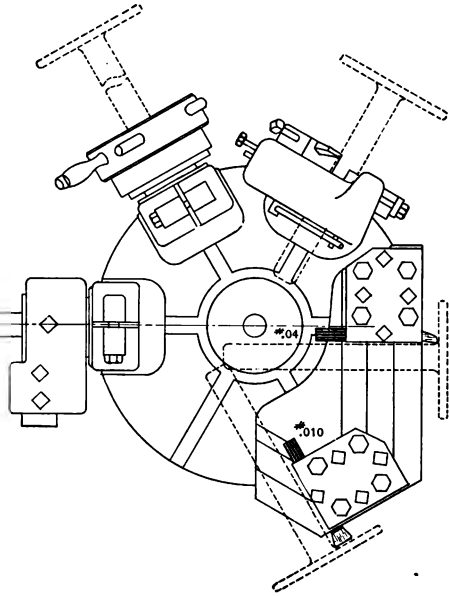


Finished in One Operation

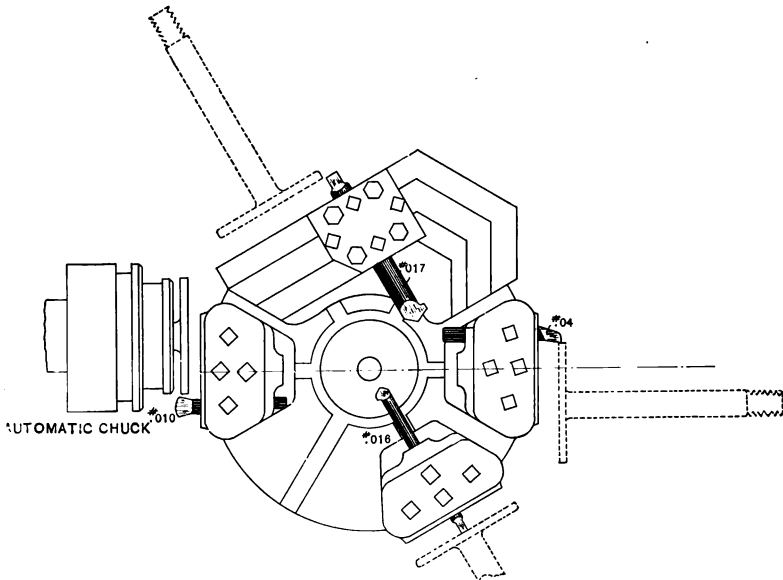
CHUCK WORK



MACHINE STEEL FORGING
FINISHED ALL OVER IN 39 MINUTES



Finished in Two Operations — First Operation

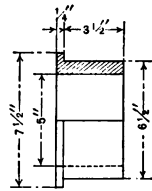


Finished in Two Operations — Second Operation

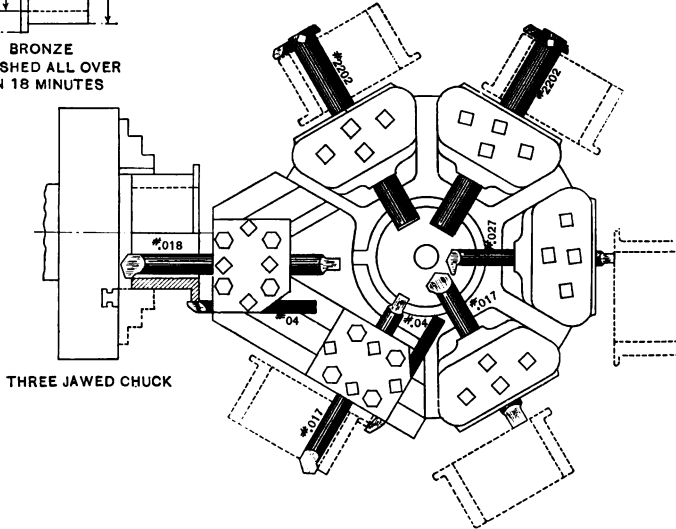
FOUR JAWED CHUCK

138

CHUCK WORK

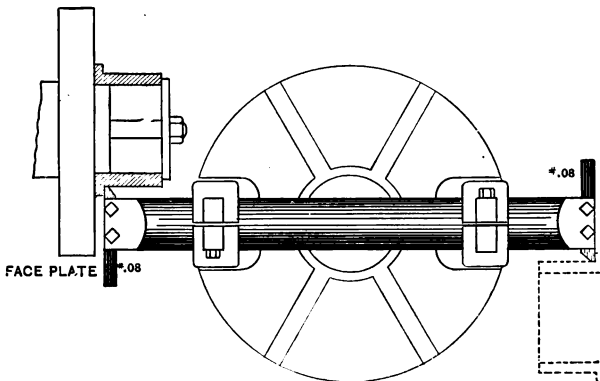


BRONZE
FINISHED ALL OVER
IN 18 MINUTES



THREE JAWED CHUCK

Finished in Two Operations — First Operation



FACE PLATE

Finished in Two Operations — Second Operation

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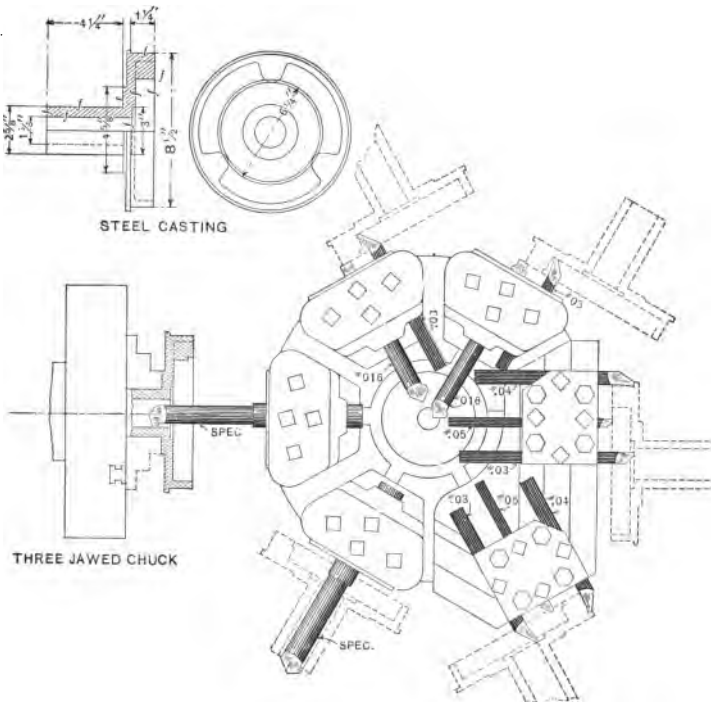


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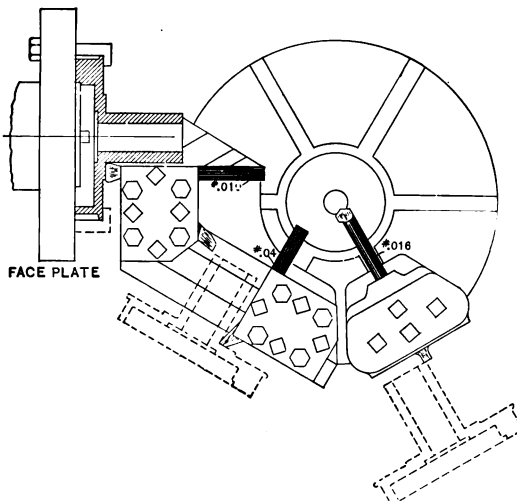


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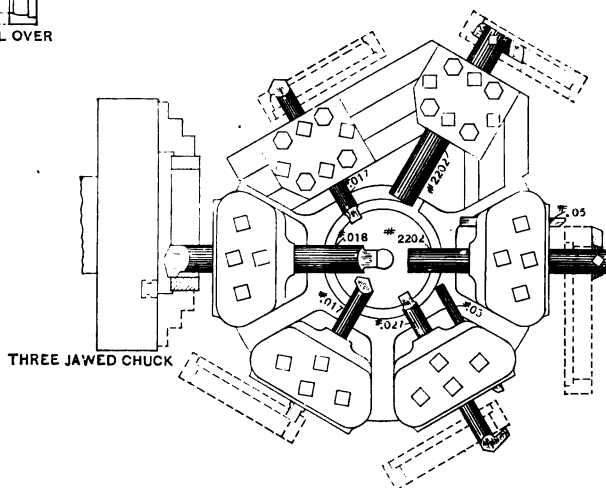
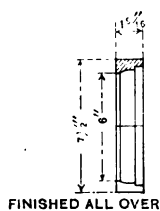


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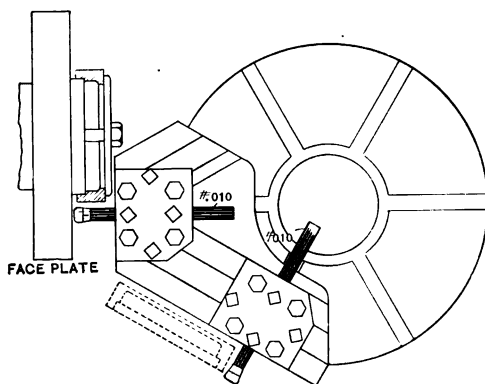


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HARTNESS FLAT TURRET LATHE

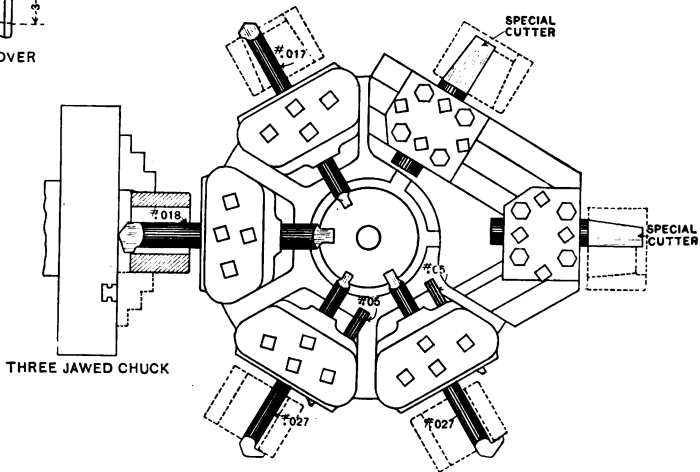
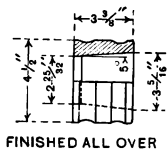


Finished in Two Operations—First Operation

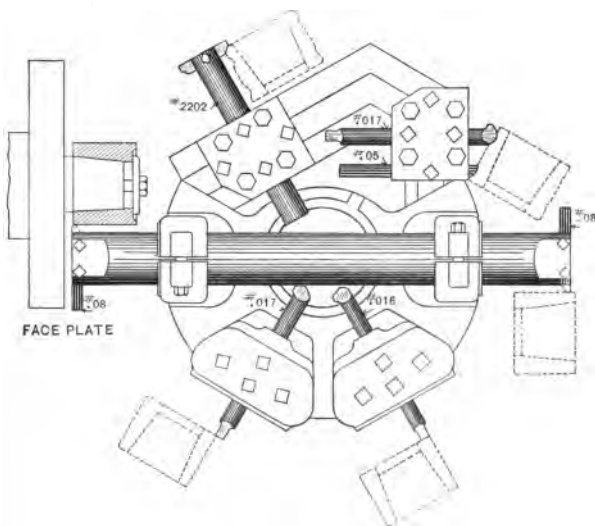


Finished in Two Operations—Second Operation

CHUCK WORK

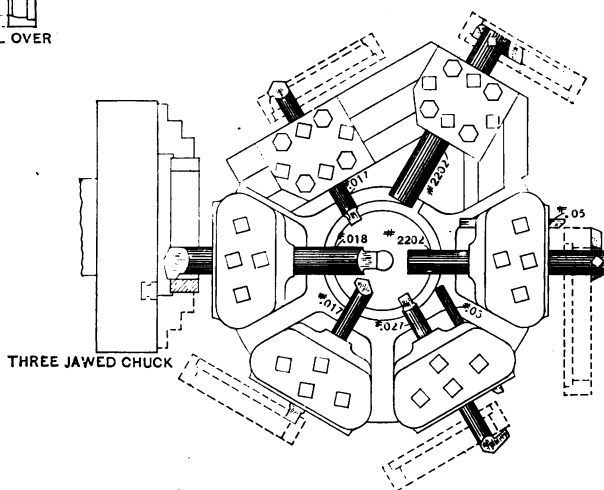
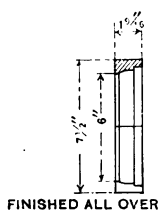


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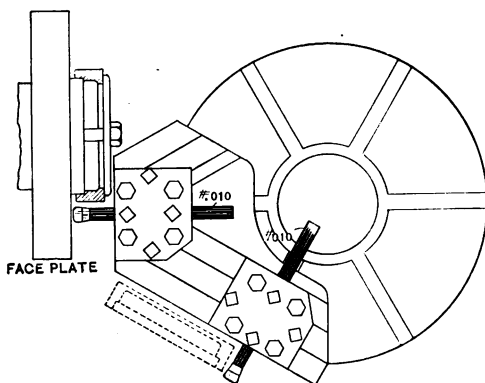


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HARTNESS FLAT TURRET LATHE

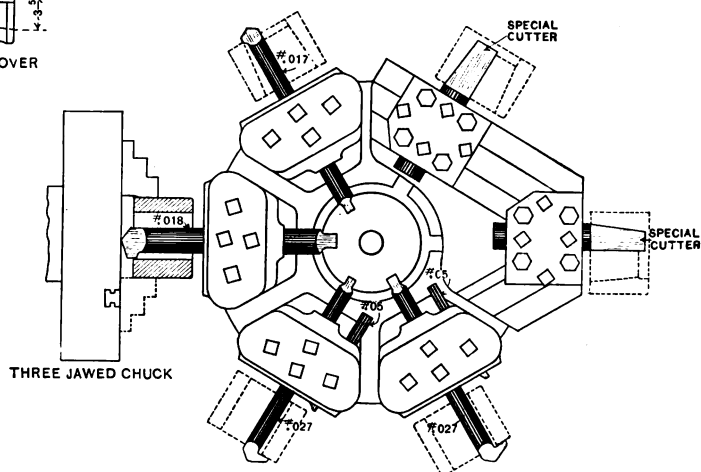
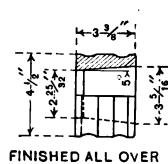


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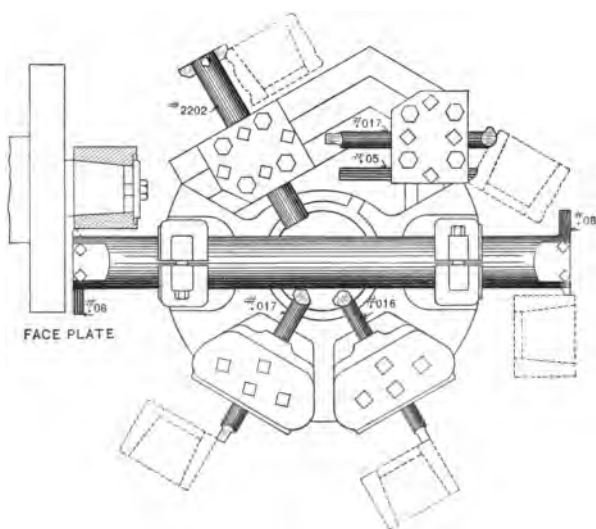


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CHUCK WORK



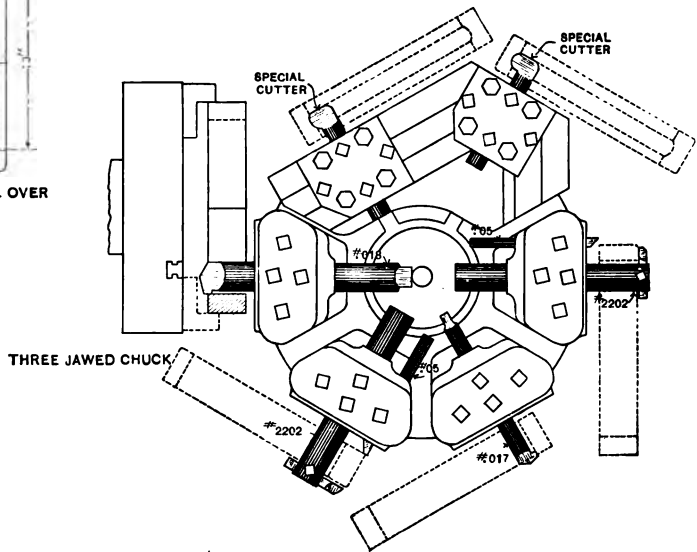
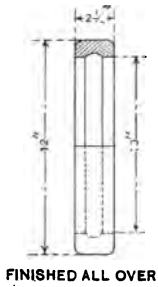
Finished in Two Operations — First Operation



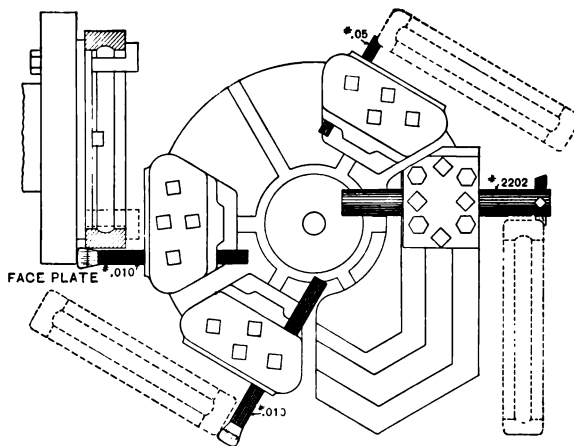
Finished in Two Operations — Second Operation



HARTNESS FLAT TURRET LATHE

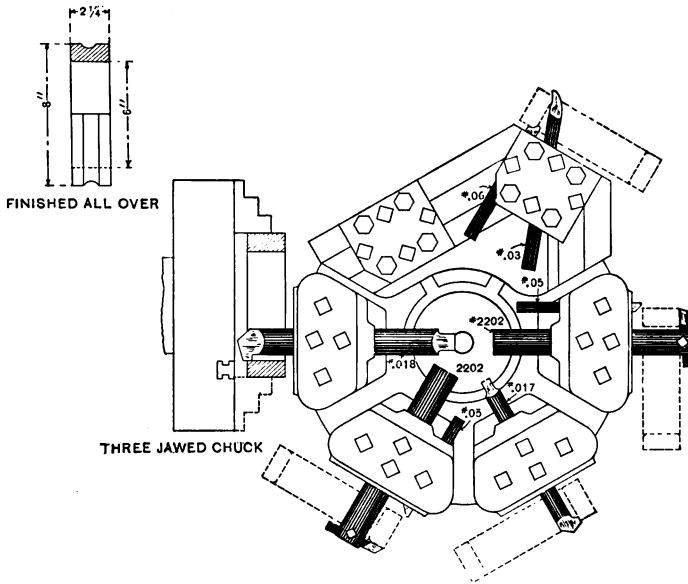


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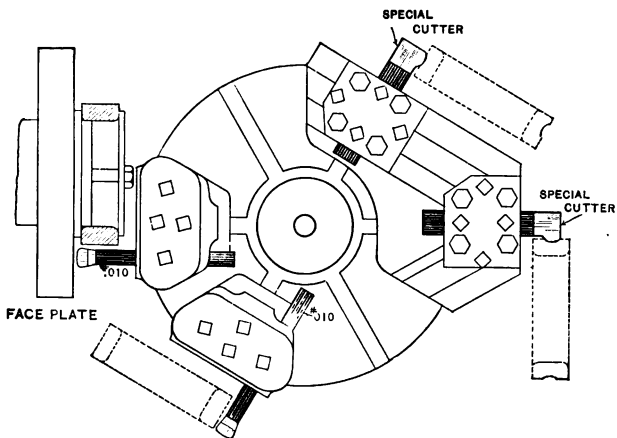


Finished in Two Operations — Second Operation

CHUCK WORK

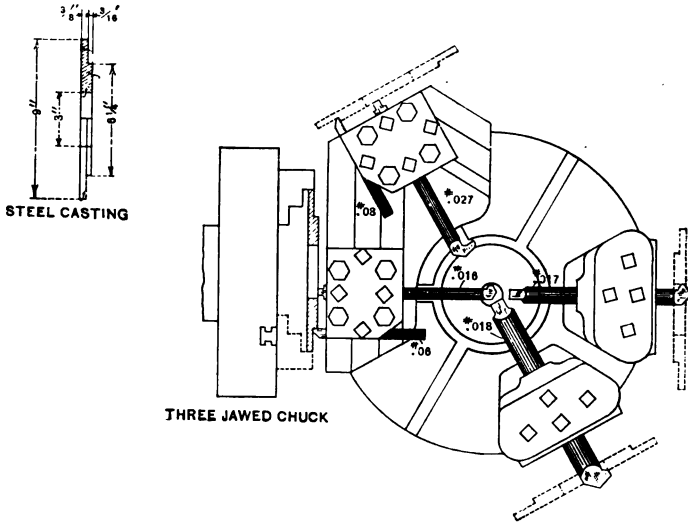


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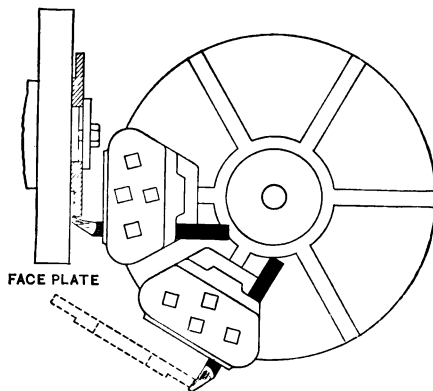


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HARTNESS FLAT TURRET LATHE

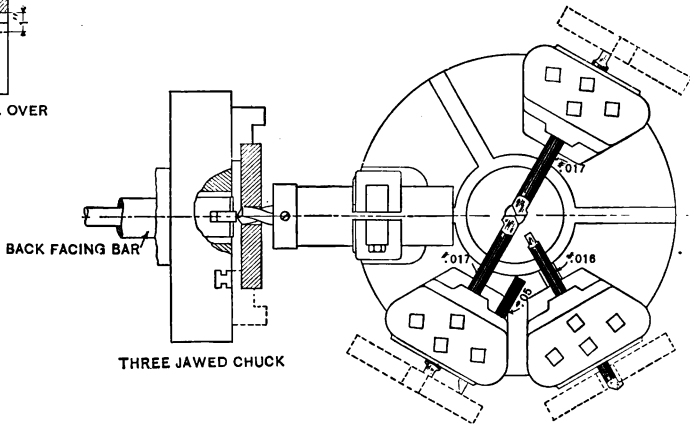
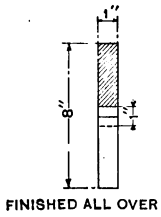


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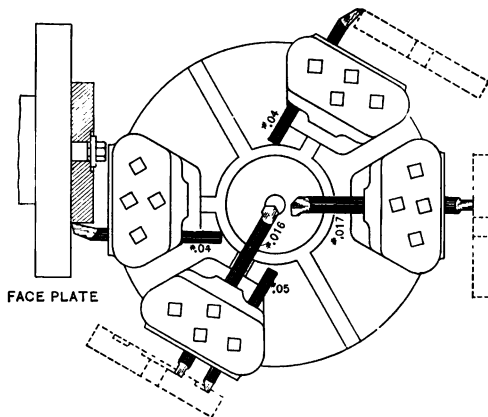


Finished in Two Operations — Second Operation

CHUCK WORK



Finished in Two Operations — First Operation



Finished in Two Operations — Second Operation

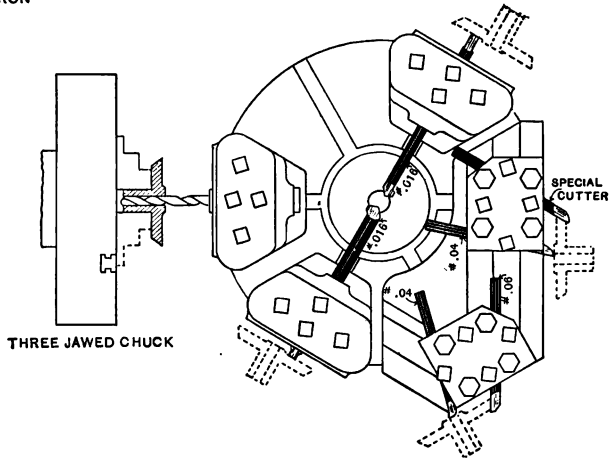
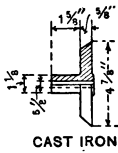
[illegible]

Diagram illustrating a turret lathe setup for a steel forging. The workpiece is held in a **THREE JAWED CHUCK**. The turret is positioned to perform operations on the workpiece. The diagram shows the turret with various tooling, including a **DRILL HELD IN CENTERING TOOL** and a **SPEG.** (Spigot). The workpiece is labeled **NE STEEL FORGING** and **ISHED ALL OVER** (likely "Finished All Over"). The diagram also indicates a **TCOL** (Tooling Control) and a **200** (likely a dimension or speed setting).

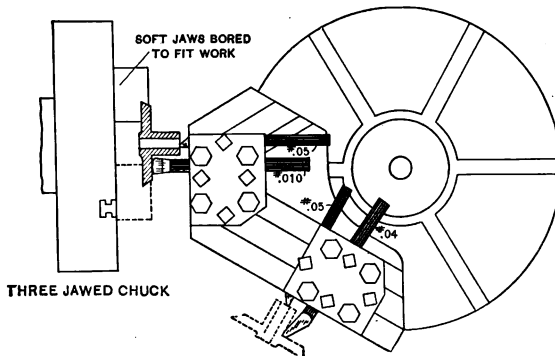
A technical drawing of a multi-spindle automatic lathe. The main part of the drawing is a top-down view of the tool turret, which is a circular component with eight tool stations. The stations are labeled with tool numbers: #2202, #2, #.01, #.00, #.010, #.00, #.05, and #.00. The turret is mounted on a central shaft. To the left of the turret is a side view of the automatic chuck, which is a cylindrical component with a central hole. The text "AUTOMATIC CHUCK" is written below this view. Dashed lines indicate the rotation of the turret and the chuck.

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CHUCK WORK



Finished in Two Operations — First Operation



Finished in Two Operations — Second Operation

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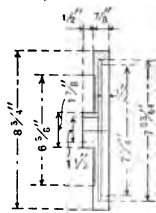


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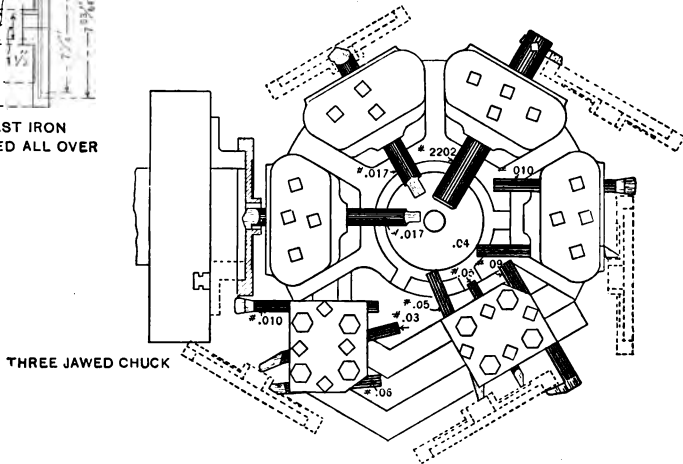


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CHUCK WORK

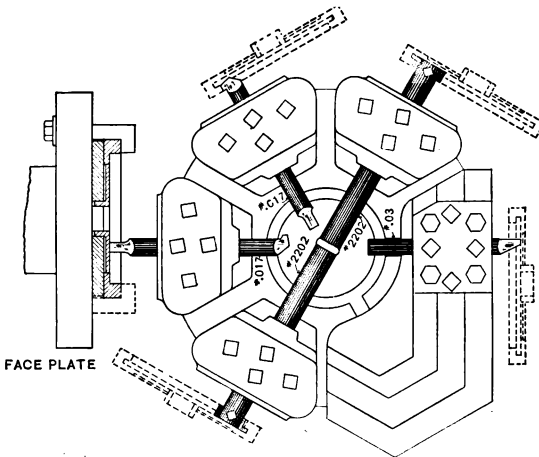


CAST IRON
FINISHED ALL OVER



THREE JAWED CHUCK

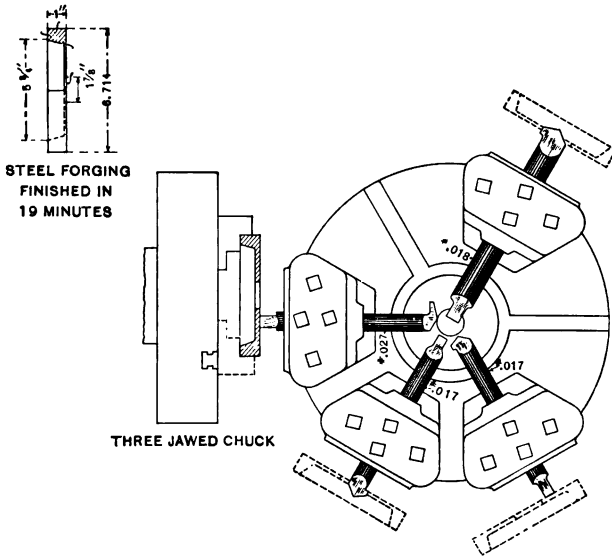
Finished in Two Operations — First Operation



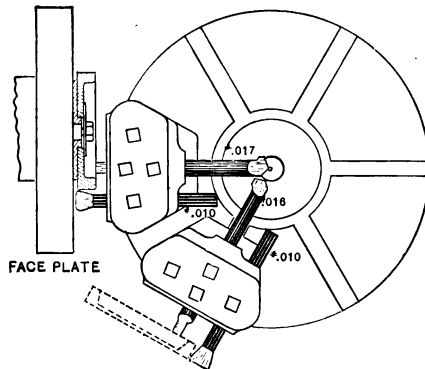
FACE PLATE

Finished in Two Operations — Second Operation

HARTNESS FLAT TURRET LATHE



Finished in Two Operations — First Operation

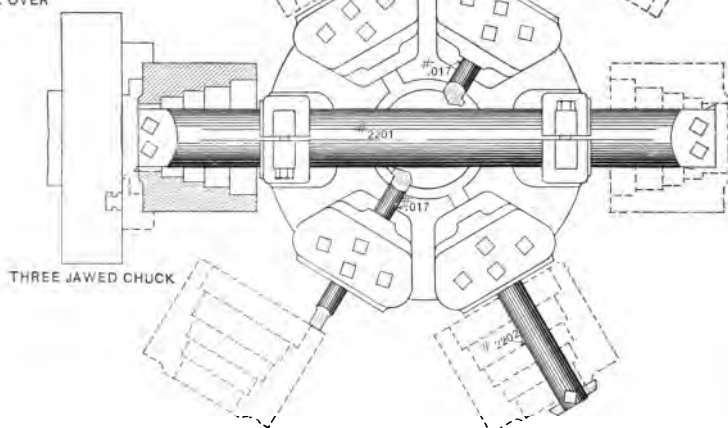
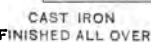


Finished in Two Operations — Second Operation

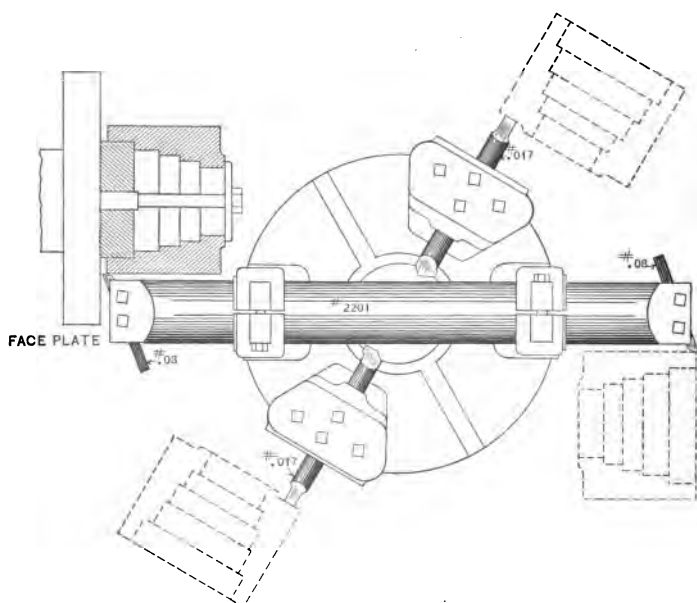
THREE JAWED CHUCK

CAST IRON
FINISHED IN 30 MINUTES

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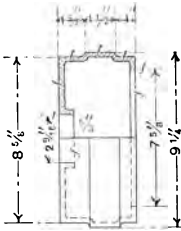


Finished in Two Operations — First Operation

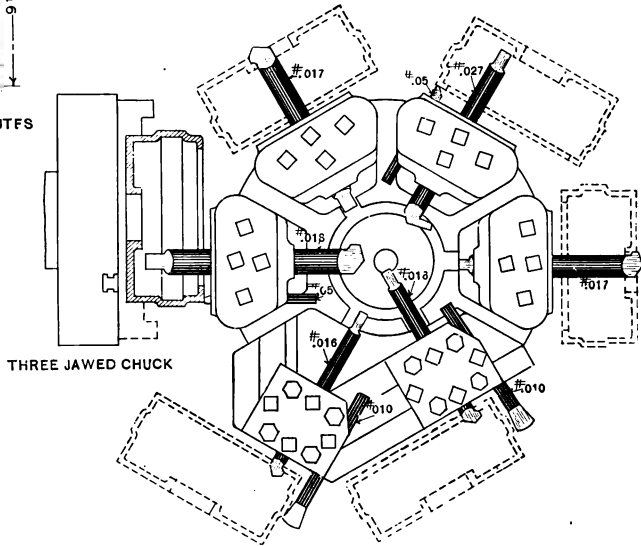


Finished in Two Operations — Second Operation

CHUCK WORK

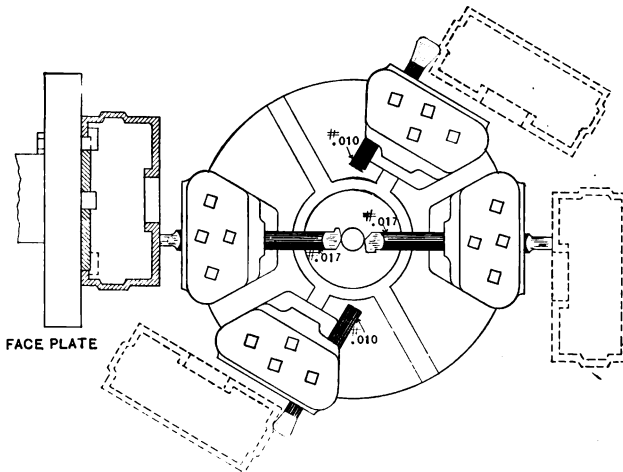


CAST IRON
FINISHED IN 24 MINUTES



THREE JAWED CHUCK

Finished in Two Operations—First Operation



FACE PLATE

Finished in Two Operations—Second Operation

CHUCKING TOOLS

THE CUTTING TOOLS FOR CHUCKING OPERATIONS, whether turning or boring, should have their rake or top slope sharp to the heaviest part of the chip. For instance, if a tool is to be used for facing a hub of a gear, the part that begins to cut first should be a sharp angle, so that the heaviest part of the chip should flow easily away, while that part of the tool that leaves its mark on the finished face should take a shearing cut or angular shaping cut, which leaves the smooth surface.

Perhaps there is no more important point to be borne in mind by anyone wishing to know how to make the machine do its best work, than the cutting angles of the tools. In a general way everyone knows that a tool should have the least amount of clearance and the greatest amount of rake consistent with the wear of the tool, but the man who makes the best record is the one who puts it into practice.

The next point is that no tool should be allowed to project beyond its holder or support more than is absolutely necessary. After having ground and set the tool properly, see that it has a chip or feed coarse enough to keep it from losing its edge in making thin chips—you have made the tool not only remove the metal, but



Boring Tool

CHUCKING TOOLS



Cornering Tool

cut it into fine chips having no special value. Even weak lathes generally do better work with a medium feed than a fine feed. It is not uncommon to see a very fine feed being used in trying to turn an extra true piece of work, with the only result that the tool does not leave an even surface. It alternately rides and “digs in” with a fine feed, when an even, steady cut would have been obtained by a medium feed.

Chattering frequently occurs because the chip is not large enough to hold all the slack of springing parts. The cure for chattering is frequently more, not less, feed. Of course, chattering may be caused by a cut that is just heavy enough to balance the weight of the work and spindle, and then the slight necessary looseness of spindle



Back Facing Tool

HARTNESS FLAT TURRET LATHE



Facing Tool

bearings gives the chance for chattering. An old-fashioned remedy for this is to turn the tool upside down to get the pressure down on the work.

Chattering is destructive of the sharp edge of the tool, and should not be tolerated.

Facing cuts may be taken by the tools with round shanks, for these can be turned so as to give the desired rake for free cutting. In facing, make sure to take advantage of the convenient means of changing the speed, for a very important reduction in time of operation as well as the durability of the tool may be effected by



Turning Tool

CHUCKING TOOLS

keeping the correct cutting speed by shifting the lever once or more times as the tool is cutting. The failure to change the speed in this way involves the selection of an average speed which is too fast at one part of the cut and too slow at the other extreme. The fast cutting destroys the edge and makes a net loss of time when the grinding and resetting are included, and of course the slow cutting is also a needless loss which does not get a corresponding durability of cutter edge.

HARTNESS FLAT TURRET LATHE



A Group of Hartness Automatic Dies

DIE-CUT SCREW THREADS

In the original development of the turret lathe for accurate lathe work, the greatest obstacle to our progress was the means then employed for cutting and measuring screws.

Die-cut threads were never correct in lead, and seldom of good shape. Lathe-cut or chased threads were found to have an error in lead averaging $\frac{1}{8}$ of an inch in 12 inches when cut by new lathes, and much greater error when produced by old lathes. On account of errors in lead and shape, neither the die nor lathe-cut screws could be measured.

The so-called screw gage used would tell how a screw would "feel" in a hole of the same length as the gage, but would never tell how it fitted.

The die which is the subject of the following description has a lead error of less than $\frac{1}{8}$ in 18 inches; it produces a shape of thread accurate beyond measure, making it possible for the first time to measure screw threads by the use of the ordinary micrometer, ring or snap gage. The introduction of this die in 1894 marked a most important step in the advancement of accurate machine construction. A full explanation of the present form follows, making very clear how such results are obtained.

GENERAL DESCRIPTION

The Hartness automatic die, shown on preceding page, is made in four sizes, viz., No. 1, for cutting screw threads from $\frac{3}{8}$ inch to $\frac{1}{2}$ inch in diameter; No. 4, for screw threads from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inches in diameter; No. 6, for screw threads from $\frac{3}{4}$ inch to 2 inches in diameter; and No. 9 for screw threads from $1\frac{3}{4}$ to 3 inches diameter.

Right or left-hand chasers are supplied as required for cutting United States Standard, Whitworth Standard, V, Acme and pipe threads; also, the various fine threads in customary use. It was designed expressly for the Flat Turret Lathe, but may be used in any of the existing screw machines or turret lathes by change of shank.

It opens automatically when the travel of its holder or shank is retarded.

The cam for controlling the chasers takes bearing directly over and very close to the cutting strains, hence there is no chance for the chaser to get away from its work by canting or tipping. This insures straight work, which is seldom obtained from other automatic dies. The connection between the shank and the body of the die is a double universal joint, allowing the die to assume any position required by the work. This connection remains perfectly flexible under the greatest torsional strain of cutting, and provides a compensation for the slight but important change of alignment that takes place in all turret machines as soon as a die begins to cut.

The latch pin which holds the cam in close adjustment is provided with two latch surfaces, one for a roughing cut and the other for a finishing cut. Turning the latch half way around changes it from one to the other without disturbing the principal adjustment for size. With this feature smooth screw threads can be cut when the lead is very coarse. It is seldom used on standard threads below 1 inch in diameter.

Every part of the die is made either from open-hearth or tool steel, the lathe work being done exclusively on the Flat Turret Lathe, and all other operations by special machinery. It is perfectly interchangeable throughout.

AUTOMATIC SCREW DIE

LEAD CONTROLLING FEATURE

The process of forming the chaser teeth is such that the front or working teeth have an ideal cutting clearance, while the back teeth have no clearance, but, instead, take bearing on the work a trifle back of the face of the chaser, forming substantially a lead nut which rides on the thread produced by the front teeth, thus governing the lead of the screw.



These chaser teeth are formed by special milling machines provided with means for recording to a nicety all angles and positions of approach of work to cutters, so that an absolute knowledge of the clearance and contact of each tooth is possessed. Each chaser is milled separately, insuring a perfect interchangeability.

The milling cutters used are $2\frac{1}{2}$ inches in diameter, regardless of the size of the screw to be cut by the chasers. These cutters are formed in backing-off lathes and possess

an ideal clearance. When in use the faces of their cutting teeth are ground frequently, thus maintaining the correct degree of rake and a keen cutting edge; they take a clean cut without any of the burnishing or rubbing action which always accompanies the hobbing or tapping of dies. The importance of this feature is appreciated after the dies have returned from the hardening process. Since the metal in the chaser teeth has been undisturbed by the cutting process, and only the extreme edge hardened, leaving the soft back very near the edge, no appreciable change of form takes place. In the process of hardening other dies the compressed or burnished metal—which has



Hartness Automatic Die No. 4 and its parts

been squeezed into shape by the hobbing or tapping action—is quick to assume a more natural position, and this results in a distorted die. Our method does not depend on the accuracy of the lead screw of a lathe in which hobs, taps and mills for producing dies are made, neither is it affected by the change in hardening such tools.

All other methods have at least the errors of two hardenings and one lead screw. We correct in the milling machine all errors excepting the final hardening



of the chaser, which takes place under such ideal conditions that we cut a practically perfect screw.

The error in lead is less than $\frac{1}{8}$ in 18 inches in screws of standard pitch, and, when cutting threads of fine pitches, a proportionate accuracy of lead is maintained.

To obtain a full appreciation of the comparative minuteness of this error it is only necessary to measure with a good scale the lead of the best taps on the market, the lead screws of engine lathes, and the screws cut by other dies, any of which will show errors from four to ten times as great. In view of these facts, we consider our die practically perfect in its lead-controlling features.

HARTNESS FLAT TURRET LATHE

GENERAL DIRECTIONS FOR USING

If the lead of the work produced does not correspond to the nut into which it is fitted, do not condemn the



die, but measure the lead of both the work and the taps with a scale, providing you can get both in length of 4 or 6 inches. It is practically impossible to make taps



that will lead accurately on account of varying results in hardening. This element of uncertainty is eliminated

in this die, as explained in the preceding pages. The error in lead of taps is usually so great that it is plainly visible on 1 or 1½ inches of length. A scale placed on tops of teeth will show at the even inches the error, and at the 1½-inch graduations if the pitch is an even number to the inch. Fifty per cent of the taps now in use should be discarded. When you order new taps ask the maker to select taps of good lead, and, if necessary, pay an extra price for getting the cream. It will be worth it if you

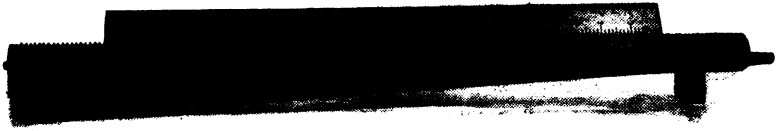


want good work. Measure the diameter of the taps and see that there are no burrs or fins in bottom of thread to spoil shape of thread in the work.

The so-called thread gages, in the form of a circular nut, though nicely finished and hardened pieces of steel with an internal thread, are very misleading.

All that has been said in the foregoing regarding the impossibility of making correct lead dies is equally true of these gages. Furthermore, such gages wear in directions for which an adjustment cannot be made. A more unreliable gage could hardly be invented.

The three distinct dimensions of a screw thread should be measured separately. The shape and lead should be measured when the die is made; in other words, the die should cut a correct shape and lead; then the third dimension, the diameter, should be measured when the die commences on a lot of screws, and occasionally thereafter. The thread may be measured by the ordinary micrometer, snap or ring gage, taking the diameter at the top of the thread.



As the die becomes badly worn, the lead should be measured occasionally. This can be done by cutting a thread 6 or 12 inches long and measuring it with a good scale, remembering that all scales may "look alike" and yet not be the same in length; hence, get a good scale.

The various forms of screw lead-measuring devices may be used with economy of time and material, but such gages should be handled with special care and occasionally compared by the foregoing method.

THE AUTOMATIC DIE

PUTTING CHASERS INTO THE DIE. One set of chasers may be removed and another put into place by simply withdrawing the two knurled thumb-screws which are located in approximately opposite positions on the cam holder. After these screws have been withdrawn

DIRECTIONS

about one-quarter of an inch the cam holder may be removed.

In changing the chasers always see that the chaser grooves in the die are wiped out clean; also that the interior of the cam holder and cam are free from chips and dirt. Place the chasers in the respective grooves in the die body by making the numbers on the chasers correspond to those on the body; then slide them towards the center till they meet. Now put on the cam holder, and, after having pushed it as far back as possible with the chasers in this position, push each of the chasers out against the cam surface; this will allow the cam holder to go back the full extent. Now see that the screws in the cam holder enter the holes in the spring collar.

TO CLOSE AND ADJUST SIZE. To close the die, pull the handle with the thumb pressing gently on the latch pin. Before adjusting the die for size see that the latch pin is in its notch and that the O. K. is uppermost; then turn the adjusting screw till the lines on the cam and chaser come together. This gives only an approximate adjustment; the micrometer or thread gage should be tried on the work. A binder screw will be found to prevent accidental turning of the adjusting screw.

ADJUSTING CUTTING LENGTH. Now the die is ready to cut its thread, but it is yet necessary to adjust the stop which will determine the length of the thread. The stop which arrests the motion of the carriage is the one which determines the length of the thread, for when the die is cutting it is only necessary to retard the travel of its holder to cause it to fly open. If the thread is to be cut close to the shoulder the stop must be so adjusted as to avoid all possibility of the chasers screwing against the shoulder. It is not safe to allow the chasers to get closer

to the shoulder than $\frac{1}{32}$ -inch. The die head travels forward $\frac{3}{16}$ -inch before opening after the carriage has been arrested.

ROUGHING AND FINISHING CUTS. One cut is sufficient for all U. S. S. threads under 1 inch in diameter, under ordinary conditions, but to obtain best results on larger dimensions, extra coarse pitch or very rough material, two cuts are necessary. The latch pin is made reversible for this purpose. It may be readily turned from one position to the other after it has been pulled out. The letters O.K. should be uppermost when the finishing cut is taken. The work should never be allowed to run backwards in the die.

CUTTING SPEEDS FOR SCREW CUTTING. Do not run your work too fast. If the pitch is extra coarse or the work warm from previous operations, the speed of threading should be proportionately slower. Better half-speed than a trifle too fast. Do not turn the part to be threaded under size, for the line of travel of the die is governed at the top of the thread, without which the die is inclined to travel crooked or to *wobble*.

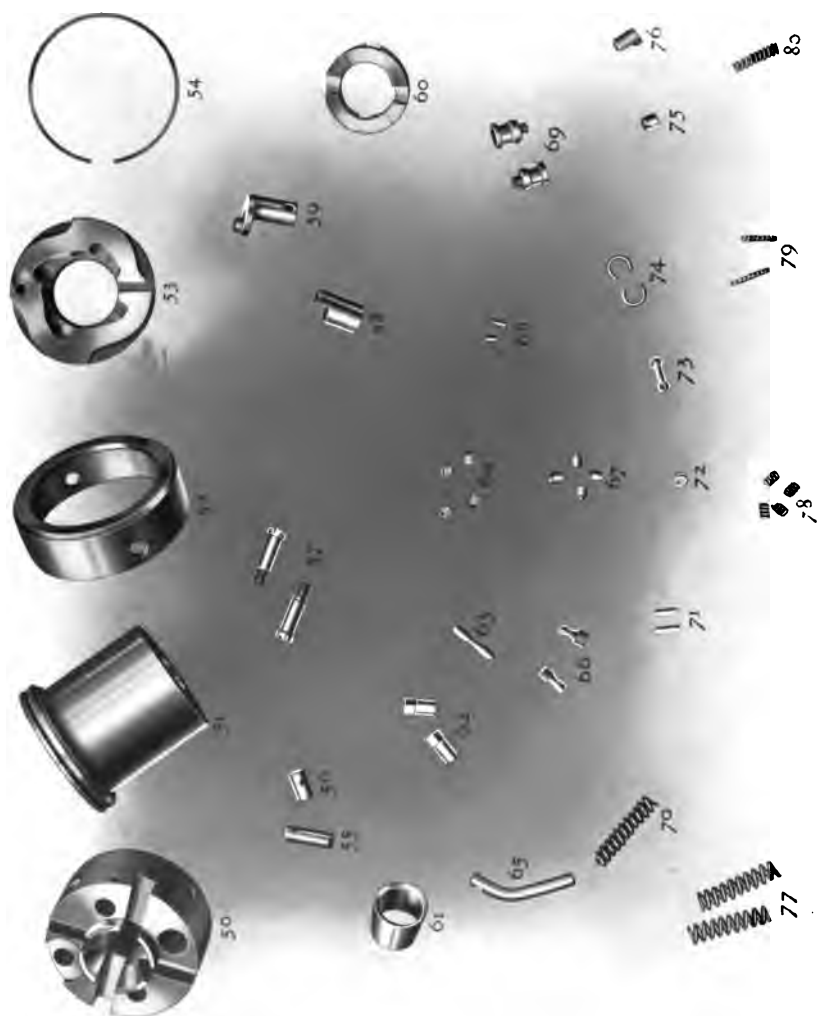
To **RESHARPEN** the dies grinding must be done very sparingly. Grind the least possible amount off the face; do the principal grinding in the throat of the die. This, of course, carries back the cutting edge into the die so far that it is impossible to cut close to a large shoulder. If the work requires cutting close to a small shoulder the chasers may be ground back enough to admit that shoulder. Some grinding must be done on the face of the die, as it wears back to the last threads, but it should be done with great care. In grinding the throat do not follow the curved lines of the teeth in order to obtain the correct clearance, for the teeth were produced by a

DIRECTIONS

mill $2\frac{1}{2}$ inches in diameter; following this shape would give too much clearance. Don't change the angle of chamfer; it is better to be guided by the wearing of the die. See that each chaser is ground an equal amount, either by gage or by bringing the teeth only to a cutting edge.

ORDERING PARTS. The chaser and all other parts of the dies are made by special machinery, and are perfectly interchangeable; any one of the standard chasers may be duplicated from stock, and special chasers on short notice, providing you give in your order all the letters and numbers appearing on the chaser. Chasers may be sent by mail. When ordering other repair parts please use list number of piece given on pages 172 and 173 and always state size of die head. The head which has capacity for threads up to 3 inches diameter is called No. 9; the 2-inch capacity, No. 6; the $1\frac{1}{4}$ -inch capacity, No. 4; and the $\frac{1}{2}$ -inch capacity, No. 1.

HARTNESS FLAT TURRET LATHE



Parts of Automatic Die No. 4

PARTS OF AUTOMATIC DIE



Parts of Automatic Die Nos. 3 and 6

HARTNESS FLAT TURRET LATHE

DETAILS OF OUTFIT OF TOOLS FOR BAR WORK UP TO 2¼-INCH BAR

The Machine One 2 x 24-inch Flat Turret Lathe, cross-feed head, single drive, four tool holders, three stock supports, oil pump and piping, friction countershaft, cast-iron table for holding tools, etc., and suitable wrenches.

Parts for Handling the Bar of Stock Automatic chuck and roller feed. Fifteen sets of jaws for chuck, holding all sizes from ½ inch to 2¼ inches in diameter, inclusive.

Turning Tools One chip breaking turner (Model K) with four independent adjustments for each back rest and cutter. One double size turning roller back rest turner (Model H) and one Model B turner without roller rests — all adjustable to sizes from 2¼ inches down. One cross slide for holding cutting-off and forming tools. One pointing tool, one centering tool, one drill chuck.

Screw Thread Cutting One 1¼-inch automatic (opening) die, with 15 sets of chasers for cutting all U. S. S. threads ⅜ inch to 1¼ inches in diameter, inclusive, by sixteenths.

All the above may be briefly described as 2 x 24-inch Flat Turret Lathe, with the automatic die outfit (outfit D).

DETAILS OF 2 X 24-INCH FLAT TURRET LATHE WITH CHUCKING OUTFIT. FOR WORK UP TO 12 INCHES DIAMETER

The Machine One 2 x 24 by 12-inch swing Flat Turret Lathe, cross-feed head, single drive, four tool holders, oil pump and piping, friction countershaft, cast-iron table for holding tools, etc., and suitable wrenches.

Chucking Tools One 12-inch face plate, with hook bolts and clamp blocks. One 12-inch 3-jawed scroll chuck with two sets 3-step jaws for in and outside gripping, one set long-necked jaws for inside gripping, and one set soft blank jaws that may be turned to fit any special form.

Four tool blocks.

One combination tool plate with clamp blocks.

One dozen outside turning cutters.

Seven inside boring and turning cutters.

Two 1½-inch round boring bars with four cutters.

One 3⅞-inch round boring bar.

Two square cutter bars with two cutters.

One extension drill support, with four sockets for standard taper shanks.

All the above may be briefly described as the 2 x 24-inch Flat Turret Lathe, with chucking outfit (outfit C).

For chuck work requiring chased threads the turret chasing tool should be added to chucking outfit. It should have one set of lead screw, nut and cutter for each pitch.

EQUIPMENT FOR 2 X 24 LATHE

DOUBLE OUTFIT FOR BAR AND CHUCK WORK: FOR BAR WORK UP TO $2\frac{1}{4}$ INCHES DIAMETER AND 24 INCHES IN LENGTH AND CHUCK WORK UP TO THE 12-INCH SWING CAPACITY

The Machine One 2 x 24-inch Flat Turret Lathe, cross-feed head, single drive, four tool holders, three stock supports, oil pump and piping, friction countershaft, cast-iron table for holding tools, etc., and suitable wrenches.

Parts for Handling the Bar of Stock Automatic chuck and roller feed. Fifteen sets of jaws for chuck, holding all sizes from $\frac{1}{2}$ inch to $2\frac{1}{4}$ inches in diameter, inclusive.

Turning Tools One chip breaking turner (Model K) with four independent adjustments for each back rest and cutter. One double size turning roller back rest turner (Model H) and one Model B turner without roller rests—all adjustable to sizes from $2\frac{1}{4}$ inches down. One cross slide for holding cutting-off and forming tools. One pointing tool, one centering tool, one drill chuck.

Screw Thread Cutting One $1\frac{1}{4}$ -inch automatic (opening) die, with 15 sets of chasers for cutting all U. S. S. threads $\frac{3}{8}$ inch to $1\frac{1}{4}$ inches in diameter, inclusive, by sixteenths.

Chucking Tools One 12-inch face plate, with hook bolts and clamp blocks. One 12-inch 3-jawed scroll chuck with two sets 3-step jaws for in and outside gripping, one set long-necked jaws for inside gripping, and one set soft blank jaws that may be turned to fit any special form.

Four tool blocks.

One combination tool plate with clamp blocks.

One dozen outside turning cutters.

Seven inside boring and turning cutters.

Two $1\frac{1}{2}$ -inch round boring bars with four cutters.

One $3\frac{1}{8}$ -inch round cutter bar for turning and boring.

Two square cutter bars with two cutters.

One extension drill support with four sockets for standard taper shanks.

All the above may be briefly described as 2 x 24-inch Flat Turret Lathe, with automatic die and chucking outfits (outfits D and C).

For chuck work requiring chased threads, the turret chasing tool should be added to the chucking outfit. It should have one set of lead screw, nut and cutter for each pitch.

HARTNESS FLAT TURRET LATHE

DOUBLE OUTFIT FOR BAR WORK UP TO 3 INCHES DIAMETER AND 36 INCHES IN LENGTH AND CHUCK WORK UP TO 14-INCH SWING CAPACITY

The Machine One 3 x 36-inch Flat Turret Lathe, cross-feed head, single drive, four tool holders, three stock supports, oil pump and piping, friction countershaft, cast-iron table for holding tools, etc., and suitable wrenches.

Parts for Handling the Bar of Stock Automatic chuck and roller feed. Seventeen sets of jaws for chuck, holding all sizes from 1 inch to 3 inches in diameter, inclusive.

Turning Tools One chip breaking turner (Model K) with four independent adjustments for each back rest and cutter. One double size turning roller back rest turner (Model H) and one Model B turner without roller rests—all adjustable to sizes from 3 inches down. One cross slide for holding cutting-off and forming tools. One pointing tool, one centering tool, one drill chuck.

Screw Thread Cutting One 2-inch automatic (opening) die, with 9 sets of chasers for cutting all U. S. S. threads 1 inch to 2 inches in diameter, inclusive, by eighths.

Chucking Tools One 14-inch face plate, with hook bolts and clamp blocks. One 14-inch 3-jawed scroll chuck with two sets 3-step jaws for in and outside gripping, one set long-necked jaws for inside gripping, and one set soft blank jaws that may be turned to fit any special form.

Four tool blocks.

One combination tool plate with clamp blocks.

One dozen outside turning cutters.

Seven inside boring and turning cutters.

Two 1½-inch round boring bars with four cutters.

One 3⅞-inch round cutter bar for turning and boring.

Two square cutter bars with two cutters.

One extension drill support with four sockets for standard taper shanks.

All the above may be briefly described as 3 x 36-inch Flat Turret Lathe, with automatic die and chucking outfits (outfits D and C).

For chuck work requiring chased threads, the turret chasing tool should be added to the chucking outfit. It should have one set of lead screw, nut and cutter for each pitch.

EQUIPMENT FOR 3 X 36 LATHE

DETAILS OF OUTFIT OF TOOLS FOR BAR WORK HANDLING FULL LENGTH BARS UP TO 3 INCHES DIAMETER—TURNING ALL DIAMETERS UP TO 3 INCHES AND THREADING UP TO 2 INCHES DIAMETER

The Machine One 3 x 36-inch Flat Turret Lathe, cross-feed head, single drive, four tool holders, three stock supports, oil pump and piping, friction countershaft, cast-iron table for holding tools, etc., and suitable wrenches.

Parts for Handling the Bar of Stock Automatic chuck and roller feed. Seventeen sets of jaws for chuck, holding all sizes from 1 inch to 3 inches in diameter, inclusive.

Turning Tools One chip breaking turner (Model K) with four independent adjustments for each back rest and cutter. One double size turning roller back rest turner (Model H) and one Model B turner without roller rests—all adjustable to sizes from 3 inches down. One cross slide for holding cutting-off and forming tools. One pointing tool, one centering tool, one drill chuck.

Screw Thread Cutting One 2-inch automatic (opening) die, with 9 sets of chasers for cutting all U. S. S. threads 1 inch to 2 inches in diameter, inclusive, by eighths.

All the above may be briefly described as 3 x 36-inch Flat Turret Lathe, with the automatic die outfit (outfit D).

DETAILS OF 3 X 36-INCH FLAT TURRET LATHE CHUCK- ING OUTFIT FOR WORK UP TO 14 INCHES DIAMETER

The Machine One 3 x 36 by 14-inch swing Flat Turret Lathe, cross-feed head, single drive, four tool holders, oil pump and piping, friction countershaft, cast-iron table for holding tools, etc., and suitable wrenches.

Chucking Tools One 14-inch face plate, with hook bolts and clamp blocks. One 14-inch 3-jawed scroll chuck with two sets 3-step jaws for in and outside gripping, one set long-necked jaws for inside gripping, and one set soft blank jaws that may be turned to fit any special form.

Four tool blocks.

One combination tool plate with clamp blocks.

One dozen outside turning cutters.

Seven inside boring and turning cutters.

Two 1 $\frac{1}{2}$ -inch round boring bars with four cutters.

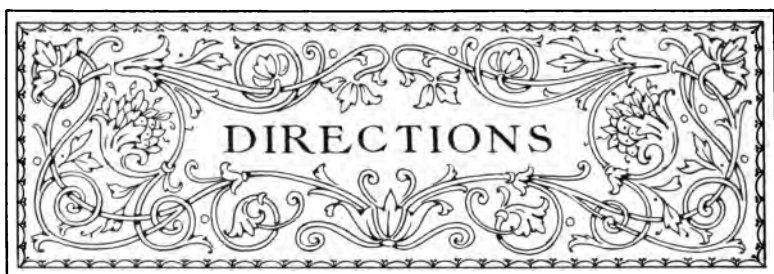
One 3 $\frac{7}{8}$ -inch round boring bar.

Two square cutter bars with two cutters.

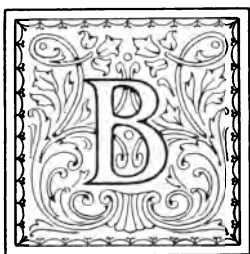
One extension drill support, with four sockets for standard taper shanks.

All the above may be briefly described as the 3 x 36-inch Flat Turret Lathe, with chucking outfit (outfit C).

For chuck work requiring chased threads the turret chasing tool should be added to chucking outfit. It should have one set of lead screw, nut and cutter for each pitch.



ERECTING



OLT the machine to the floor before putting on the belt. Do not adjust the position of the machine to the running of the belt. Set the machine true with the countershaft or main line by dropping down a plumb bob from each end of the shaft. Since plumb bobs are not in the kit of every machinist, an inch nut or any weight on the end of a string thrown over the shaft will answer.

The countershaft should line up perfectly with the shaft from which the power is received, and it should be perfectly level. It should be well oiled before starting and examined after it has run fifteen minutes to see if any of the bearings are warm.

After the machine has been set parallel with the counter the lag screws should be put through the legs into the floor, but should not be screwed down until after the machine is leveled. As the bed rests on three points and is flexibly connected to one pair of legs, the leveling of the machine is not done in the usual way. When the level is placed across the Vs of the lathe bed and is found to be a little high on one side, drive the wedges under the edge of the leg at head end. Do not try to change it by wedging up under the back leg, for it is not connected to the bed by the usual means, but only serves as

DIRECTIONS

a pivotal support. Wedging under this leg will only raise or lower this end of the machine. Care should, however, be taken to have this leg stand on a fairly level spot. Now place the level on one of the Vs lengthwise and wedge up carefully until both ends of the machine are equal in height.

Locate the stock supports as indicated in the drawings and adjust them for height by placing a bar of stock in the machine and slowly revolving it.

If the countershaft clutch slips, screw up the two small nuts at the rim of friction and slightly turn each the same amount. The speed should be exactly 800 revolutions per minute. If this speed is not as prescribed, the table of sizes of work for which the various speeds are intended will be of no value. This table is furnished for ready reference in a suitable frame with each machine.

Do not put your belts on too tight at first. It is much easier to lace the belt two or three times while it is stretching than it is to get a new bearing running smoothly after it has been roughened up by the belts being too tight. All new bearings should be frequently oiled and run with care.

GROUPING MACHINES

Turret lathes for chuck work may be grouped in any convenient way.

If there is no bar work to be considered, then the machines may stand parallel to the main line of shafting or to the sides of the building, but if the machines must handle long bars of stock, then it is necessary to place the machine at an angle of about 20 degrees to the sides of the building or main line, in order to allow the bar of one machine to pass back of the machine next ahead.

The electric motor drive is most convenient for this service, but the countershaft drive may also be used by

crossing the vertical belt. This, of course, requires the countershaft to run in the reverse direction to that shown in cuts to maintain the proper motion of the pulley on the lathe.

There will be no difficulty in locating the lathe in relation to the countershaft if you will see to it that a plumb line hung over the center of the belt surface of the counter pulley at its front side will just touch the middle of the front face of the belt surface of the pulley on lathe.

This, of course, is not theoretically correct, but it works well in practice.

When you cross the belt see to it that you twist it in the direction that leaves the belt free from contact at the place of crossing.

In locating the lathe, the cross sliding head should be in central position with the center of its spindle in line with the center of the turret.

In some instances it is desirable to omit the countershaft and place a main line directly over the line of lathes. This may be accomplished by the addition of a tight and loose pulley on the lathe head, providing the machines stand parallel with the shaft above, or by use of friction clutch pulley, providing the lathes must stand at an angle.

LUBRICATING OIL IN HEADSTOCK. Put five gallons of lubricating oil in the case of the sliding head. The lightest or thinnest oil is the best. There is an overflow hole drilled at the proper level in the back of the head case. The oil should always be kept up to this level—if the oil is allowed to get too low there is sure to be trouble.

COOLING SOLUTION OR LARD-OIL. If the machine is to be used in working steel, the reservoir in pan should be filled with either good No. 1 lard-oil or a mixture of lard-oil with borax and water—about 10 or 11 gallons are required.

The change from the carbon to the so-called high speed steels has effected the problem of cutting solution.

DIRECTIONS

Lard-oil is undoubtedly the best and only cutting oil for tools made of carbon tool steel, and perhaps for all tools taking a broad cut, like a forming tool, but now it is better to use a solution made of one pound of borax to seven gallons of hot water mixed with one gallon of lard-oil.

The quantity of borax should be the least that will make the water and oil mix. Sal soda may be used but the quantity should be the least that will make the oil and water mix.

This quantity varies with different waters (hard or soft) and unfortunately with different lard (?) oils, depending on the proportion of lard-oil to the adulterant and the quality of the adulterant. But a safe mixture in the usual circumstances may be made in accordance with the above formula.

A convenient amount may be mixed in a 50-gallon barrel which will take 7 pounds of borax with water heated to 100 or 110 degrees. Allow the solution to cool and then add 7 gallons of No. 1 lard-oil.

Borax is better than sal soda, which has heretofore been used for making a cutting solution known as soda water.

The objection to an excess of either borax, or sal soda, is that it cuts away the lubricant from the sliding surfaces, and causes an excessive wearing away of the sliding surfaces between the turret and the saddle, and the saddle and bed.

If borax water is used instead of clear lard-oil, provision should be made for a daily supply of a good quantity of oil (preferably lard-oil) to the turret seat and carriage slide; otherwise, these surfaces will rapidly wear down.

Lard-oil is preferred for lubricating the turret and carriage-slides, because it finally gets into the cutting solution and improves the quality of the solution, whereas other oils have the adverse effect.

Borax water and soda water compounds both have a common characteristic which seems to cause a wearing

away of the clearance-face of the tool. This face of a worn tool looks as if it had been lapped; that is, a tool loses its clearance quicker with soda or borax water than with lard-oil straight, and a tool refuses to cut because its under-face has been worn to a slightly negative clearance, whereas the tool dulled by cutting with lard-oil has a crumbled edge which has grown into a negative clearance.

The cooling qualities of borax water are very much greater than those of lard-oil.

It is, of course, much cheaper than straight lard-oil, for the quantity of oil and borax per gallon is relatively inexpensive.

DIRECTIONS FOR STARTING ON BAR WORK

TO START THE MACHINE ON BAR WORK, begin on some very simple work. Suppose the diameter of the head is $1\frac{1}{2}$ and the body $1\frac{1}{4}$ inches, that the total length is 6 inches, and that the piece must be finished all over. Get a bar of $1\frac{7}{8}$ -inch stock. See that it is fairly straight and free from short kinks and that there is no burr of any size on either end. If the bar has been cut off in the shear the burr should be hammered down. The large adjusting collar under the sleeve should be screwed back to open the chuck and forward to close it. Now remove the bushing from the spindle, for this is only used for smaller bars than 1 inch, and would not admit the $1\frac{7}{8}$ -inch bar. It is necessary to let back the rolls in the roller feed in order to remove this bushing. After this is done push the bar through the stock supports into the spindle and through the chuck until the end projects about $\frac{3}{4}$ -inch beyond the face of the chuck. Adjust the jaws at the back of the roller feed till they are about $\frac{3}{16}$ -inch loose on the stock. Adjust the chuck till it requires much force to thrust the chuck lever to the left. The rolls of the roller feed should be set down against the bar till each spring is raised a trifle.

DIRECTIONS

Now, the next thing is to determine the speed to be run. This can be done by the use of the table or by experience. Turn the turret around until the cross slide comes in working position, set the cut-off tool, and trim off the rough end of the bar. Before turning to the next place set the stop. See directions for adjusting the stops on page 185. No. 1 is the stop for the cut-off slide. Next move the "back stop" up close and clamp it. Run the turret back against it till it turns to the next position; next loosen the back stop again and push it back till the end of the swinging "stock stop" measures a distance equal to the length of the work, which is 6 inches, plus the width of the cut-off tool, which we will call $\frac{1}{8}$ -inch. That is, the stock stop should be swung up into place, and the turret should push the back stop until the length between the end of the bar in the chuck and the end of the stock stop is equal to $6\frac{1}{8}$ inches; then clamp the back stop firmly.

Now open the chuck and hold the lever to the right until the roller feed pushes the bar out against the stop, then forcibly close the chuck. Turn the turret to turner. Now use the turner carefully and without the back-rest till the cutter is adjusted to size. This must be done on the first piece by use of calipers or any other gage; take off about $\frac{1}{8}$ -inch chip each time while roughing, and allow it to run on about $\frac{3}{4}$ -inch. After the end has been reduced to $1\frac{1}{4}$ inches, adjust the back-rest, have it follow the tool and bear on the $1\frac{1}{4}$ -inch size, then throw in the feed by the lever on the front of the apron near the pilot wheel. Let this cut run up the required distance and adjust the feed stop for this tool.

Before running back withdraw the tool by pulling the small cam lever towards you. Run back the turret until it brings the next tool into position, and adjust this tool for turning the head of the piece; the head may be turned without the use of the back-rest.

Now the end of the piece may be shaped by the pointing tool held in one of the tool holders. The screw cutting comes next. Directions for using the automatic die will be found on pages 168 to 171. The next operation is rounding the head, which may be done by an offset tool in the back tool post of cross slide, or it may be done by putting a crowning tool in place of the cut-off tool and then having the cut-off tool work from the back post of cross slide. By using the former instead of the latter an additional tool may be set in the back post for shaving the under-side of the head. This, however, is not often necessary. Then cut the piece from the bar and proceed to run off the required number.

If but one piece is desired it is not necessary to set any of the stops. These stops were set only for the benefit of more rapid production of the other pieces wanted. In starting the turner on a piece of this proportion do not throw in the feed until the edge of the back-rest is started on the work; it should be fed thus far by hand. The fine feed should be used with a chip of this kind, but if the tool is beveled slightly the medium feed can be used.

IF THE BAR IS CROOKED and the end runs out too much to true up, the piece may be partly severed from the bar—enough to weaken it so that it can be bent to run true.

THE JAWS MAY BE USED ON WORK A TRIFLE LARGER, but never on smaller diameters than are marked on the jaws. For instance, the $1\frac{7}{8}$ -inch jaws will hold $1\frac{5}{8}$, but will not hold $1\frac{3}{4}$. The latter size must be held by the $1\frac{3}{4}$ -inch jaws.

HEXAGON STOCK is held by the same jaws that hold round and square by removing one of the jaws and inserting spacers that will hold the jaws in place for taking bearing on three sides of the stock. Round stock

DIRECTIONS

may be held in the jaws as arranged for holding hexagon or square, but if it is a trifle oval in section, an arrangement of jaws for hexagon is better.

THE CHUCK should be wiped clean every time the jaws are changed, and should be kept well oiled. To remove the chuck from the spindle of the 3-inch machine it should be gripped on a short piece of 2-inch stock to which a lathe dog is fastened. By the use of a lever placed between the tail of the dog and the bar of stock, the chuck may be readily loosened. This also serves as a good means of screwing the chuck firmly against the collar when putting it on again.

The chuck body of the 2-inch machine is part of the spindle and cannot be removed.

THE ROLLER FEED should be kept as clean as possible and well oiled. The bar of stock should be wiped free from grit and dirt before the bar is placed in the machine.

THE TURRET STOPS AND HOW TO ADJUST THEM. There are twelve feed stops for the turret, two for each position of the turret. These stops are numbered A-1 and B-1 for No. 1 turret position, and A-2 and B-2 for No. 2 turret position, and so on up to 6. The lever marked stop controller is arranged to lift out of position all of the A stops or all of the B stops, or both the A and B stops. When only one stop is required for each position of the turret, the stop controller is set to keep either the A or B stops out of position, allowing the others to do the work.

If more than two stops are required for any one position, then the extra stop pin at the back of the turret slide may be dropped into any one of the other five holes, thus borrowing one or more of the B stops not required by the other tools. This extra stop scheme makes it possible to give one of the tools seven stops, if desired, and still leave one stop for each of the other five tools.

Each of the twelve stop bars is held in place while setting by the set screw directly over it, but these set screws should not be set down hard or depended upon for holding against the carriage feed. The stop binder at the side clamps all of the stops together, and should be set hard.

The notched edge of the stops should be up when the stop is to arrest the forward motion of the carriage, and down when stop is to arrest motion of carriage traveling away from the chuck.

The back stop serves two purposes: first, it forms an abutment for the rack that turns the turret; and, second, it determines the backward travel of the turret, and thus locates the stock stop which is attached to the turret carriage. The back stop should be set with reference to the desired position of the stock stop, against which the bar of work strikes when a new length of work is being pushed out of the chuck. Care in setting the back stop will leave very little to be done in adjusting the screw at the end of the stock stop.

TURNERS B AND H. The adjustments for the turning tools and for the back-rests are provided with binder screws to prevent their moving after being once set. These screws are set up with a screw-driver from the back of the turner. For all kinds of work set the tool so that the part of it that does the finishing is just a trifle ahead of the back-rest. The tool should be so adjusted that the part that does the finishing will come exactly to the center of the bar when the tool holder is swung in. The two cams are diametrically opposite and side by side. The lever for turning the cams is like a machinist's vise handle. When one end is up one of the cams engages one of the adjusting screws, and when the other end of the handle is up the other cam is brought against the other adjusting screw.

DIRECTIONS

THE CUTTING TOOL USED IN THE TURNERS B AND H should be ground so as to leave a square shoulder. This form of cutting edge, with plenty of rake, or top slope, is the best for this service, although it is not the form of tool for work on which the back rests cannot be used.

It is the best for producing true work because the cutting pressure which is to hold it into its chip is mostly end pressure on the work, and not radial — that is, no very great pressure is required to hold it into the proper depth to produce the desired diameter, hence a slight variation in depth of chip due to eccentricity of stock has little or no tendency to spring the work away from the tool. For this reason this tool may be depended upon for true work in taking long cuts, even when the stock runs a trifle crooked.

THE CROSS SLIDE is arranged with stops for the front and back tools. The upright which supports the pinion shaft is bored out to receive bushings for supporting the work against the forming tool when it is necessary to use a broad tool near the end of a slender piece of work.

NEVER USE A DRILL THAT IS LONGER than is absolutely necessary. If the depth of the hole is to be great in proportion to its diameter, a short, stiff starting drill should be used to start a true hole. Never drill beyond the piece that is to be cut off, for after the piece has been cut off and the bar run out to make another, it will be found that the end does not run exactly as it did when it was drilled into, and consequently the hole runs out. In some cases, where the mouth of the hole is to be larger, it does not make any difference, because the larger drill will true the hole, but generally it makes trouble that is difficult to overcome without the waste of stock.

THE STOCK-STOP SCREW must be lengthened out when drills are used, and the length of the extension should be equal to the length of the longest drill used.

FEEDS AND SPEEDS

MEANING OF "FEED." The rate of advance or traverse of the tool to each revolution of the work is expressed in parts of an inch.

For instance, 100 feed means that the tool advances $\frac{1}{100}$ -inch per revolution of the work, and that the chip consequently is metal that was that thickness before it was severed from the work.

Likewise, 20 feed indicates that the rate of travel has been $\frac{1}{20}$ -inch per revolution, or 20 revolutions required to carry the tool one inch.

The demand for accurate work tends toward the use of the finer feeds, and the demand for rapid output tends a trifle toward coarse feeds.

The feed should always be coarse enough to take a steady cut; feeds finer than 80 or 90 in lathes of 12 or more inches of swing frequently give an unsatisfactory surface due to the chip being too light to maintain a steadying effect.

When the feed is too light, as in feeds, say of 100, in such lathes, the work has a surface which is produced by the mixture of scratches and burnished rings, for the tool point has alternately rubbed by riding and scratched by digging in. Therefore, the feed for all purposes should be heavy enough to get a continuous and steady cut. In the work under consideration, this is a feed between 80 and 90 per inch on steel and 60 to 90 on cast-iron.

The product is nearer straight and true from the finer feeds, providing the excessively fine feeds are not used.

The demand for rapid production calls for running coarse feeds when it can be done without a corresponding reduction in running speed.

On both cast-iron and steel the feed should be as coarse as 90 per inch and a gain is sometimes made by

DIRECTIONS

running 80 per inch on both cast-iron and steel, but there is no gain in coarser feeds on steel work; for in turning tough metals like steel the coarse feeds necessitate a corresponding reduction in speeds but this does not hold true of cast-iron.

But remember through it all that after the feed has been selected the speed must be run up as high as the tool will stand.

The endurance of the turning tool should be at least two hours in the present machine. Forming tools or screw cutting dies must be run at much slower speeds.

MEANING OF "CUTTING SPEEDS." Cutting speed means the speed at which cutting edge passes through the metal. It is expressed in feet per minute.

In lathe work, the cutting speed may be determined by use of a Warner cut-meter or similar instrument, or by the use of a speed table which is usually furnished with each lathe.

In absence of these, the speed may be calculated by multiplying the circumference of the work by the number of revolutions per minute, and divide by 12 to get it into feet. The circumference should be taken at the largest diameter of the cut for all work. In exact experiments the mean diameter is taken, but for turret lathe work the largest diameter gives the best means of comparison, for the depth of cut does not generally call for a reduction in speed, particularly on work below 3 inches in diameter where a cut, say of $\frac{1}{2}$ -inch deep, reduces the 2-inch to 1-inch diameter, would give a cutting speed which would be very high if the mean diameter of $1\frac{1}{2}$ inches was taken as a basis of determining the correct cutting speed.

Furthermore, the cutter of any turner having a good back-rest wears most at the part of the bar that travels the faster; the point of the tool generally holds out the longest.

The point of the tool wears off faster when the tool and work are not held together by back-rests. This is also true of cast-iron work. On the larger work the depth of cut is seldom sufficient to greatly reduce the cutting speed at the point.

The scale or skin may safely be disregarded on both cast-iron and steel, being frequently offset by other elements.

One of these elements in the turret lathe is the fact that in taking the first cut (which encounters the scale) the work is cold, whereas the later cuts must start with warm work.

THE EFFECT OF RATE OF FEED ON RATE OF SPEED. The cutting speed is generally stated to be directly affected by the size of the chip, but this does not apply to the average work under consideration.

In the work of the Flat Turret Lathe the cutting speed is generally affected by the thickness of the chip only—and not by the width of the cut.

If 50 feet per minute is the fastest cutting speed at which a tool will stand satisfactorily at 30 feed, then the same tool will run 100 feet per minute at 60 feed per inch.

The speed should be up to a high standard, and always above 50 feet per minute, and with present steels speeds of from 50 to 150 are practical on average machinery steel.

The exact statement of cutting speeds is impractical on account of the rapid progress that is being made in the art of making high-speed steels; but there is one safe rule, and that is, to run each tool up to its best performance, and if that is too low, according to the latest information, see to it that you get the best steel.

Do not let your product or your personal record be kept down by a poor piece of steel. Cutting tools are

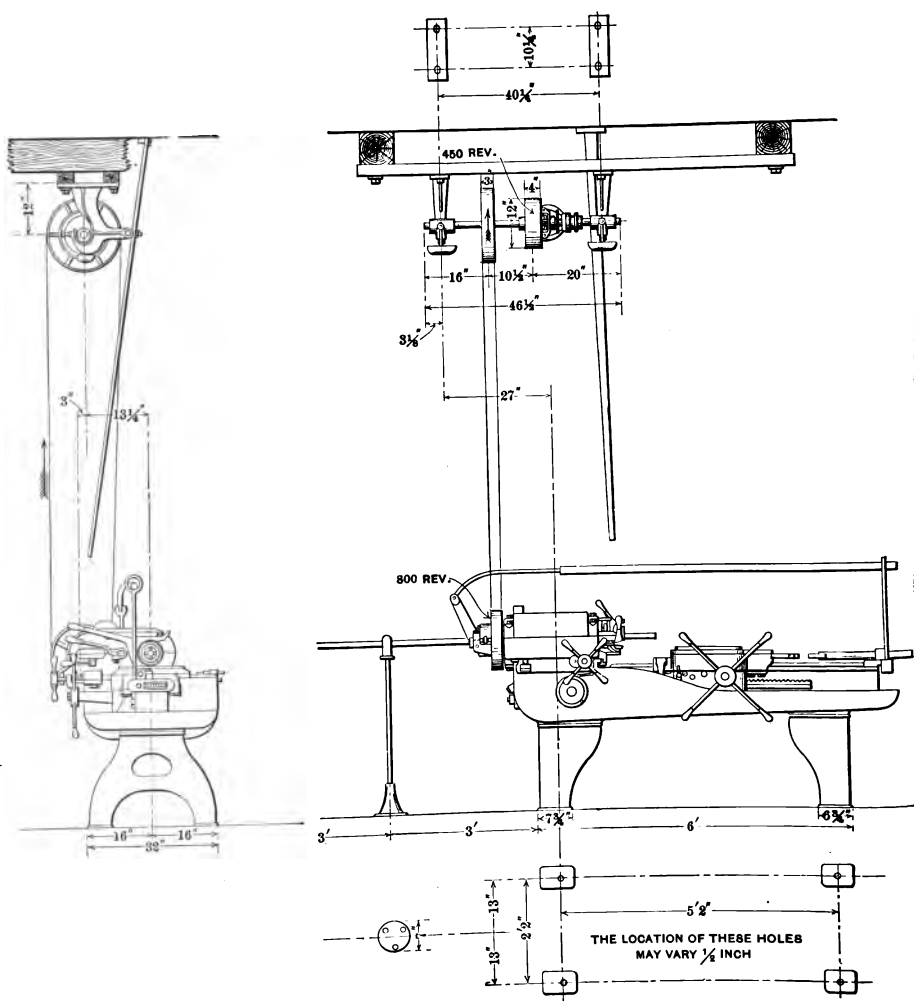
DIRECTIONS

cheap and good reputations and output are valuable; hence it is well to know that you are getting there at the proper speed.

Many a careful man has become a marked man just because he thought the cutting tool could not stand a higher speed. His experience may have fully warranted his conclusion, but he got his experience with some "out-of-date" steel or a poorly hardened or poor piece of later steel.

When personal records are so easily injured, when output is so easily increased, it behooves every man to give heed to the subject of speed and feeds.

HARTNESS FLAT TURRET LATHE

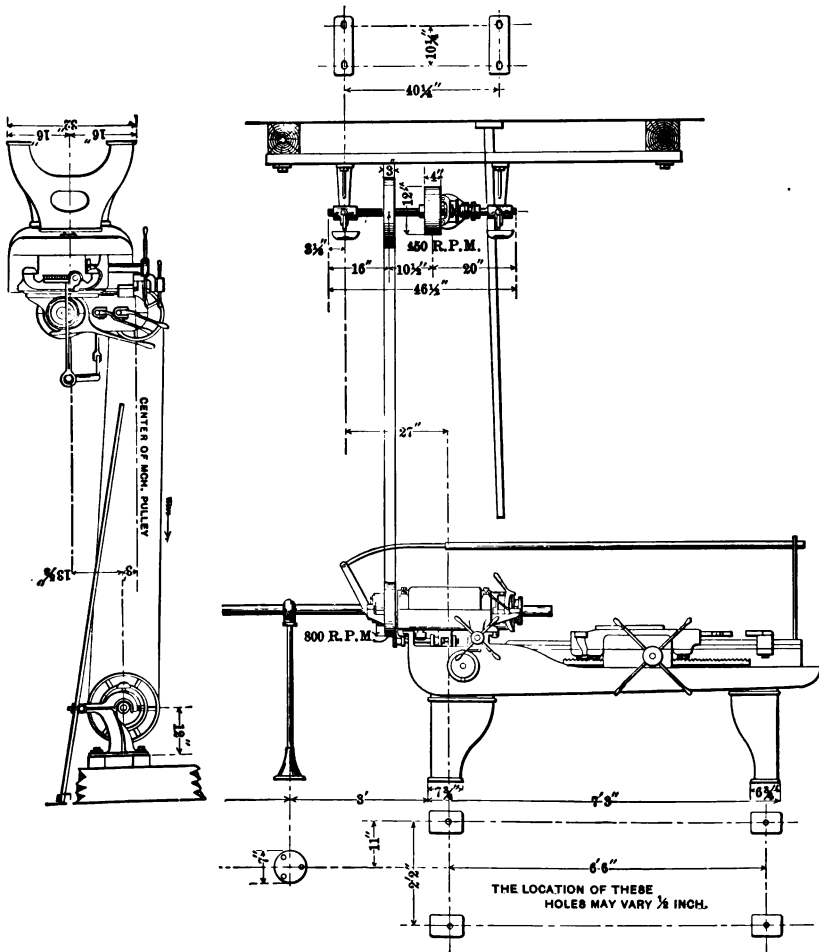


Plan for Setting up 2 x 24-inch Flat Turret Lathe with Countershaft

Three stock supports are furnished and should be located as shown in cut on page 194

See directions for grouping, page 179

COUNTERSHAFT DRIVE PLAN

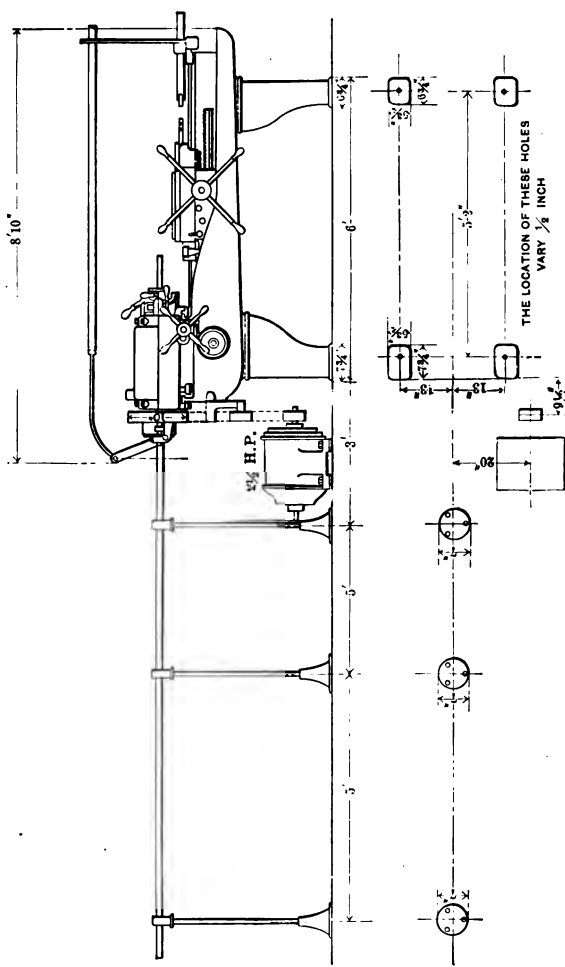


Plan for Setting up 3 x 36-inch Flat Turret Lathe with Countershaft

Three stock supports are furnished and should be located as shown in cut on page 195

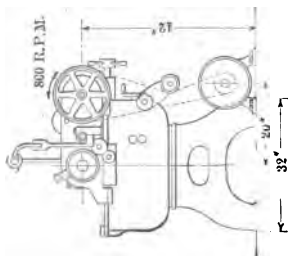
See directions for setting machines in groups, page 179

HARTNESS FLAT TURRET LATHE



2 x 24-inch with Electric Motor

The motor is bolted to floor and an idler pulley running on slack side of belt compensates for the change in center distance as the sliding head travels. The starting box may be attached to the face of the machine or to the iron work table which accompanies each machine having the chucking or bar outfit. Any constant-speed motor may be used. No variation in speed is required in the motor, neither is it necessary to reverse the motor, for all such changes are obtained by mechanism in the head. See page 106 for self-contained motor drive.



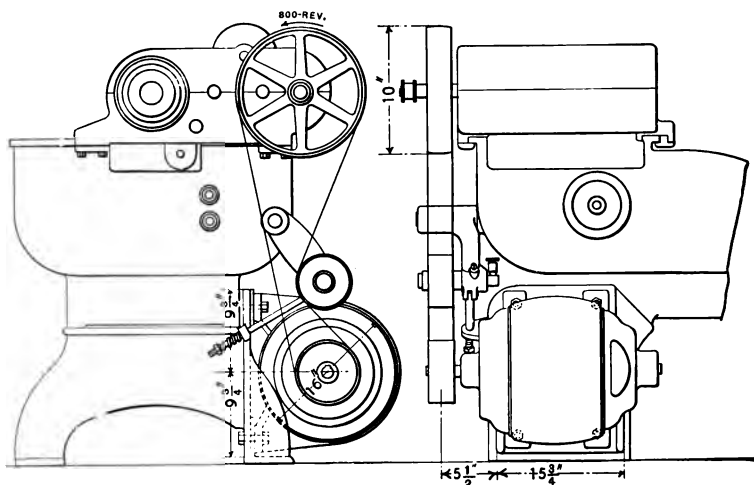
SPECIAL ELECTRIC DRIVE WITH MOTOR ATTACHED TO MACHINE

The regular machine is driven by an electric motor as shown on pages 194 and 195.

This special electric drive is intended to meet the demand for motor attached to machine.

This scheme of drive requires a special leg having a face to which the motor may be bolted; otherwise the machine is the same as regular.

We are prepared to furnish motor or to furnish machine with special leg of the dimension given below, to which the purchaser may attach motor. The latter method generally is saving in time. It is only necessary to see that the motor selected will go in the space provided on leg. This is only furnished on special order clearly stating that motor leg is preferred.



SPECIAL FEATURES

SPECIAL FEATURES

The open-side turner is occasionally used for special work, having short cut of over $2\frac{1}{4}$ and under 3 inches in the 2 x 24-inch lathe, and over 3 and under 4 inches in the 3 x 36-inch machines. Only recommended for taking light cuts.



Open-side Turner

Herewith is shown the centering tool, for drilling centers in work for grinding or other purposes. By careful adjustment of two of the back rests just a little nearer the center than the third rest absolutely true centering can be done.



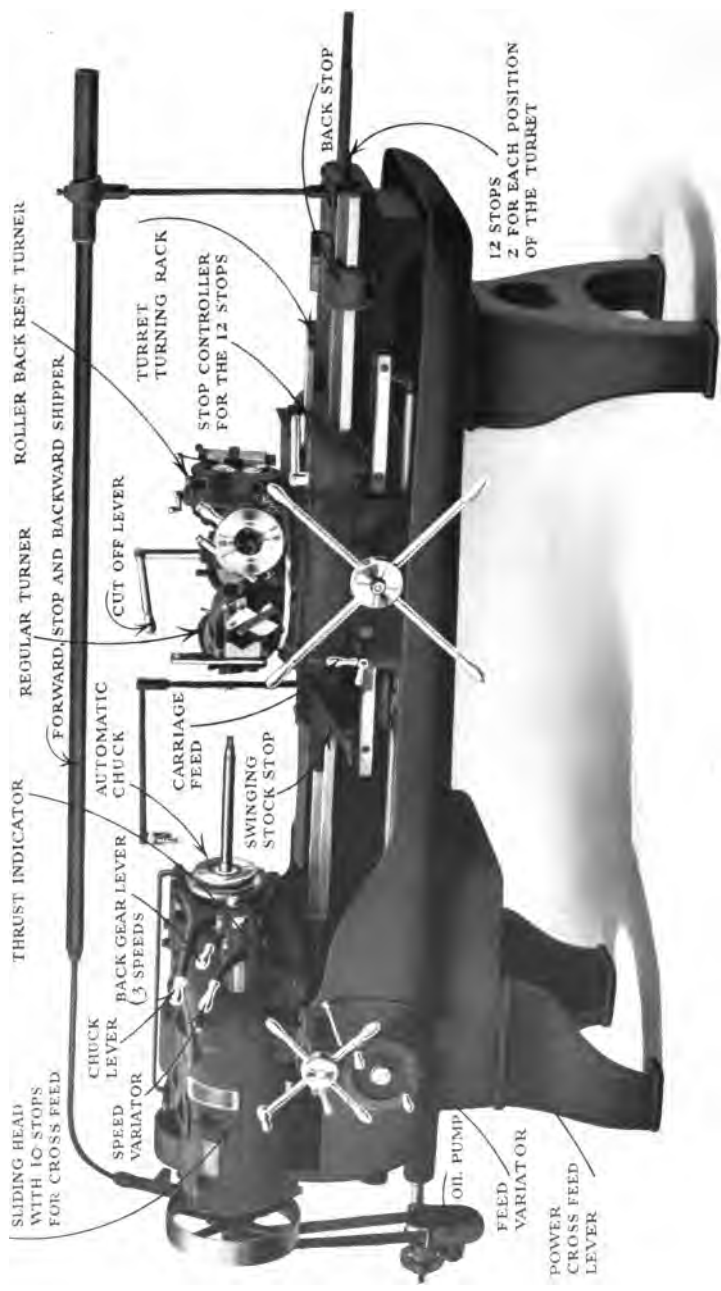
Centering Tool

The clutch tap holder is used for holding a tap against turning until it has tapped to a desired depth, at which point the carriage is stopped, causing the clutches to pull apart and allowing the tap to rotate with the work until spindle is reversed for screwing it out.



Clutch Tap Holder

HARTNESS FLAT TURRET LATHE



SLIDING HEAD WITH 10 STOPS FOR CROSS FEED

CROSS FEED STOP SHIFTER

FEED INDICATOR

CHUCK LEVER

SHIPPER ROD FOR FORWARD STOP AND BACKWARD MOTION TO SPINDLE

STOP CONTROLLER

CARRIAGE BINDER

SPEED VARIATOR

SWINGING STOCK STOP

THROW OUT POWER FEED

THROW IN POWER FEED

BACK STOP

12 TURRET STOPS 2 FOR EACH TURRET POSITION

REVERSES TURRET FEED

OIL TO TURRET TOOLS

POWER CROSS FEED LEVER

PUMP

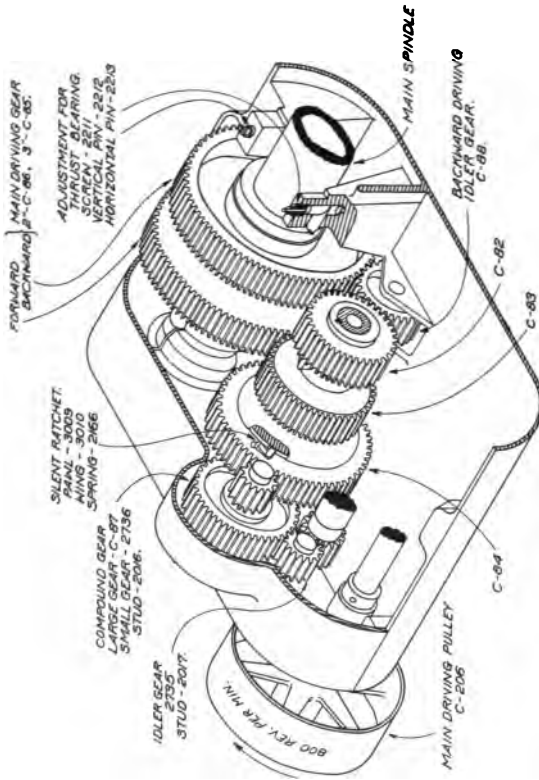
BELT TENSION RELEASE ROD

FEED VARIATOR

LOCATION OF SERIAL NUMBER OF MACHINE. REFER TO THIS NUMBER WHEN ORDERING PARTS.

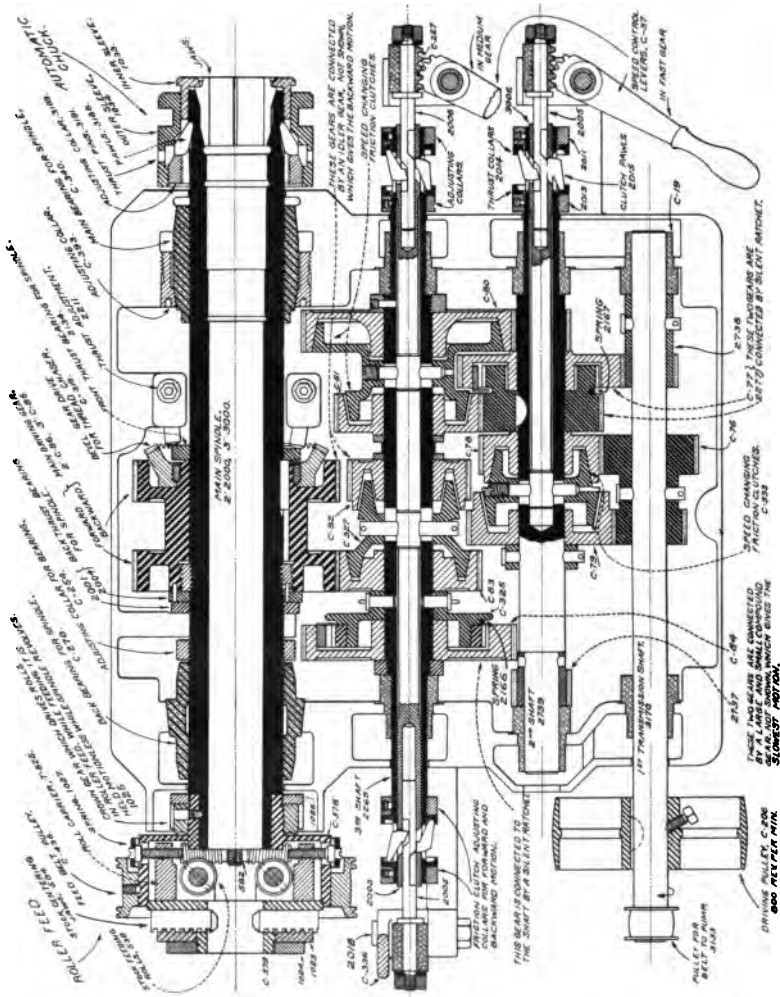
LENGTH OF FEED BELT
APPROX. FEED BELT 35 INCHES IN LENGTH
FEED BELT 35 INCHES IN LENGTH

HARTNESS FLAT TURRET LATHE



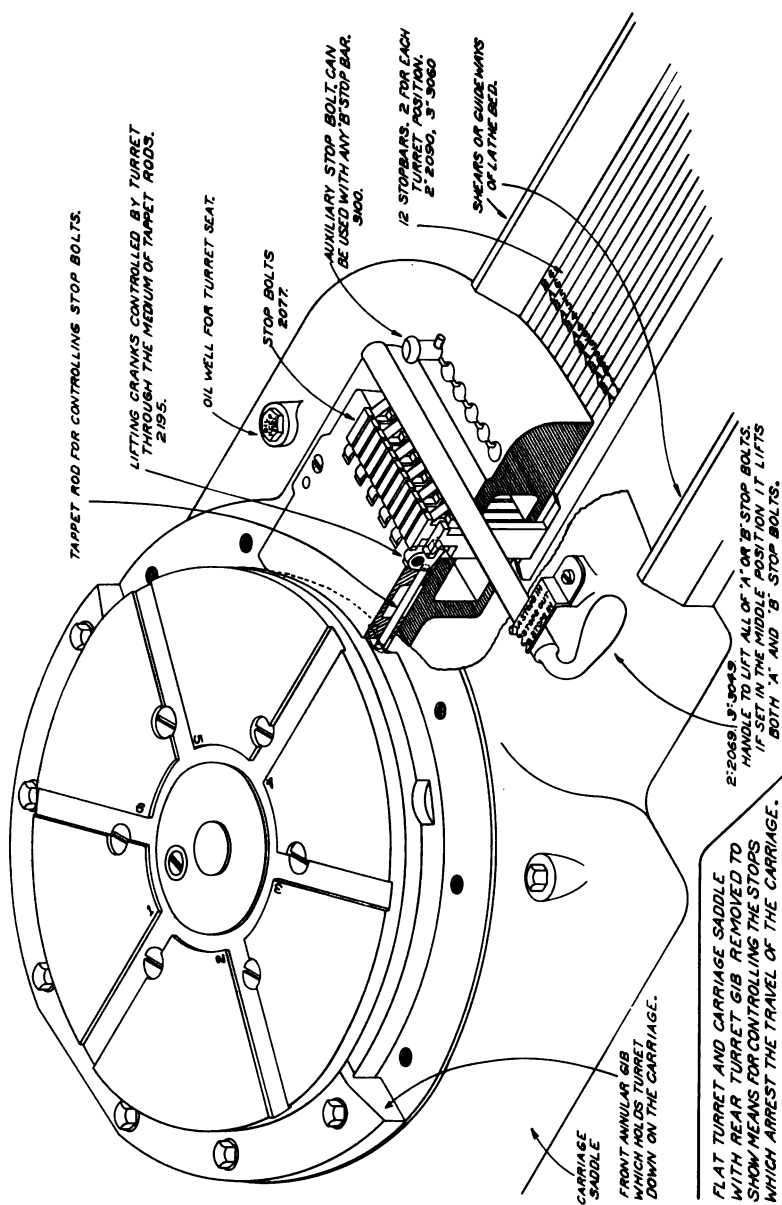
3 x 36-inch Headstock. Partial View Showing Reverse and Back Gearing

OPERATOR'S SECTION

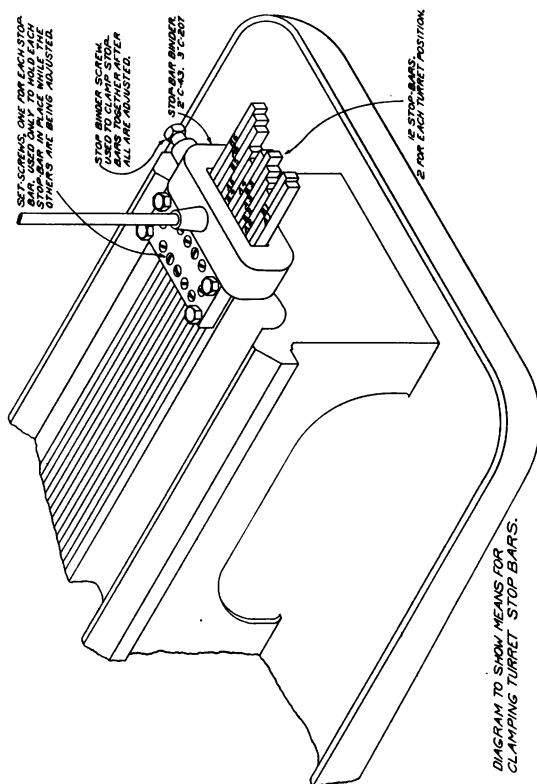


2 x 24-inch Headstock. Section through Spindle Drive Gearing

HARTNESS FLAT TURRET LATHE

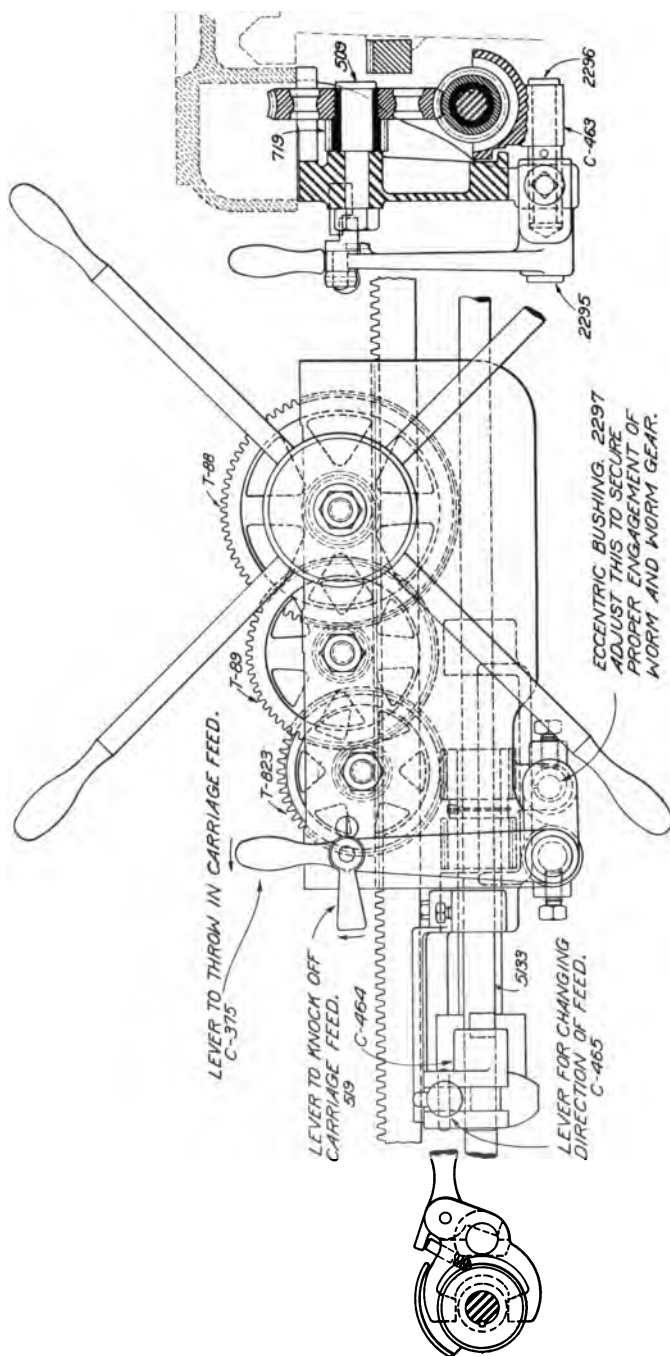


OPERATOR'S SECTION



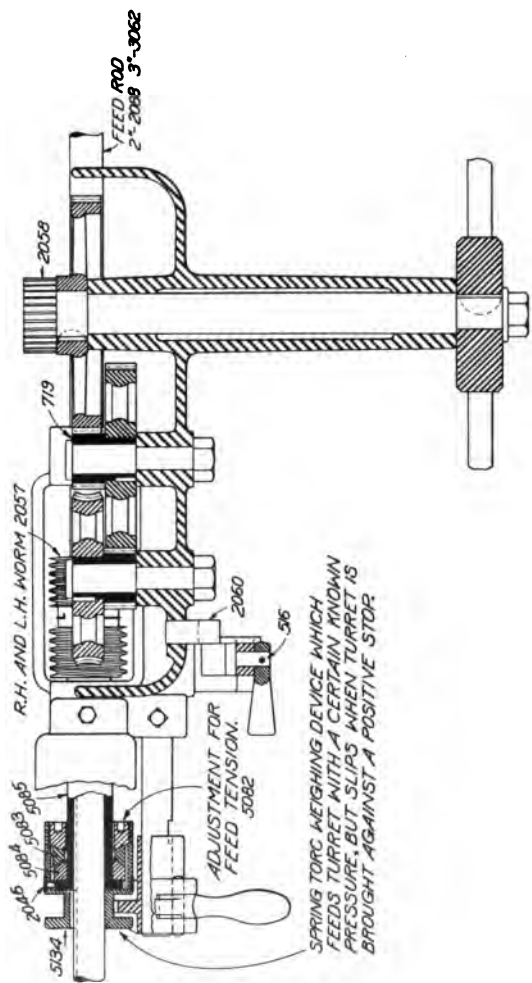
Rear End of Lathe, Showing Method of Clamping Carriage Stop Bars

HARTNESS FLAT TURRET LATHE



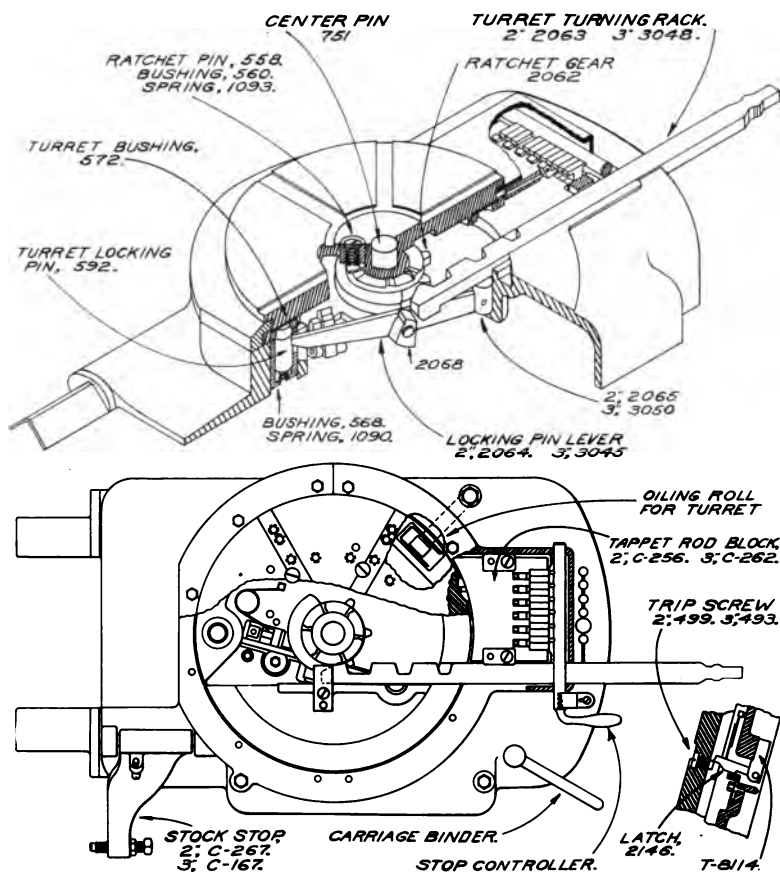
Feed Gearing on the Carriage — Front View and Section

OPERATOR'S SECTION



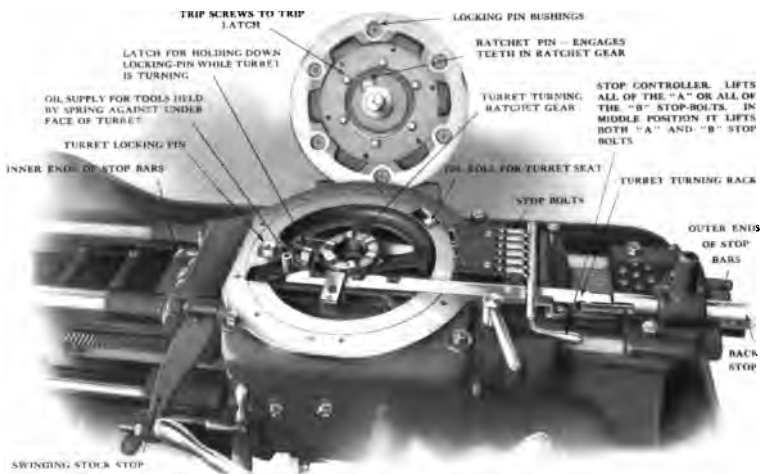
Feed Gearing on the Carriage --- Horizontal Section

HARTNESS FLAT TURRET LATHE



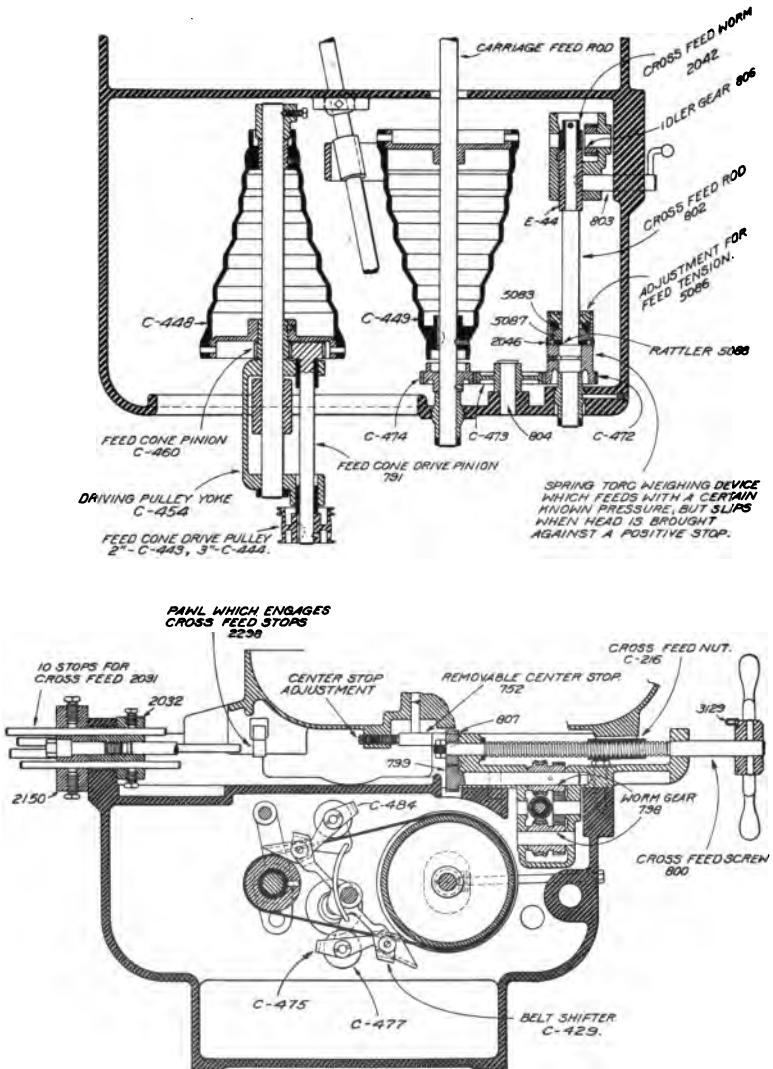
Plan and Section of Turret and Carriage

OPERATOR'S SECTION



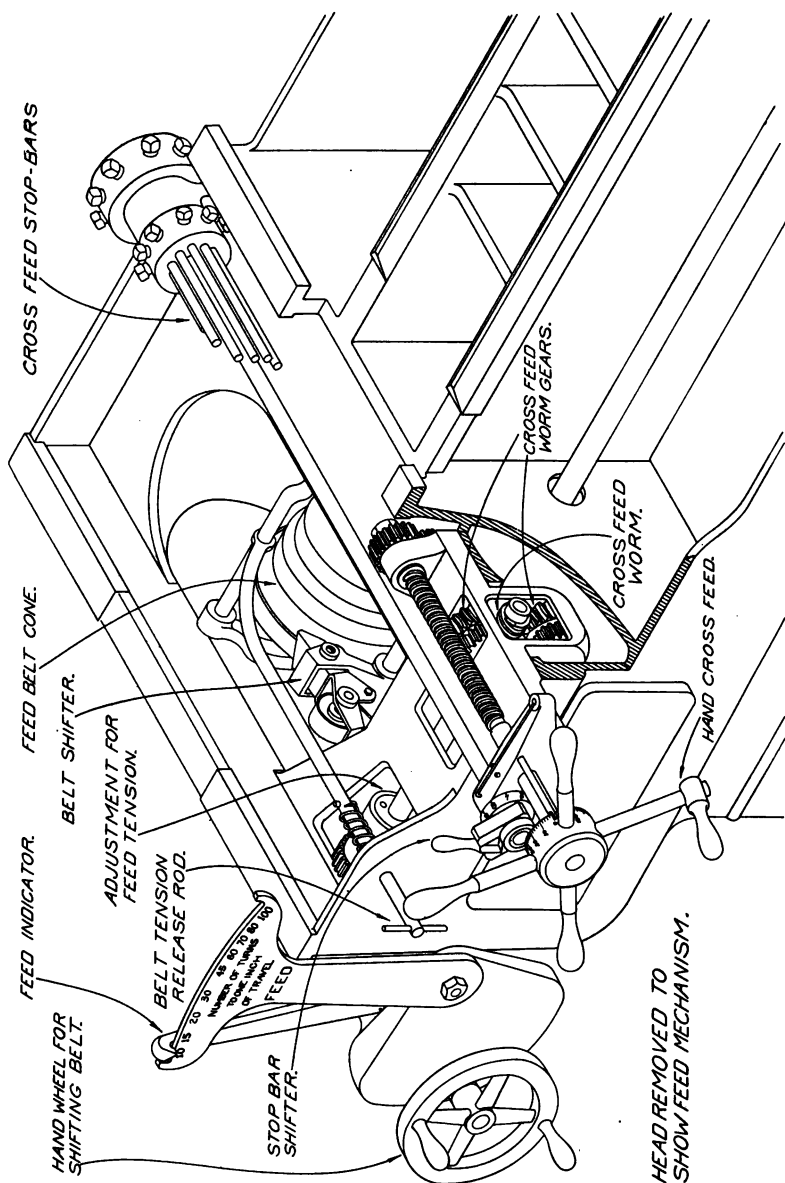
Flat Turret lifted to show Revolving and Locking Mechanism. Also parts for Controlling Carriage Stops

HARTNESS FLAT TURRET LATHE

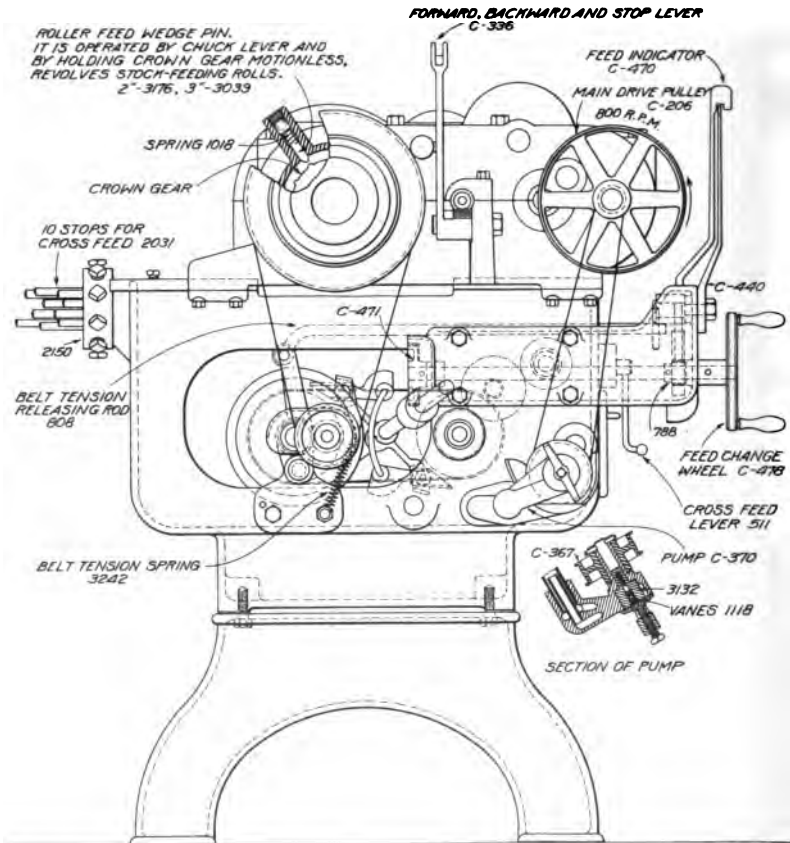


Sections showing Feeding Mechanism

OPERATOR'S SECTION

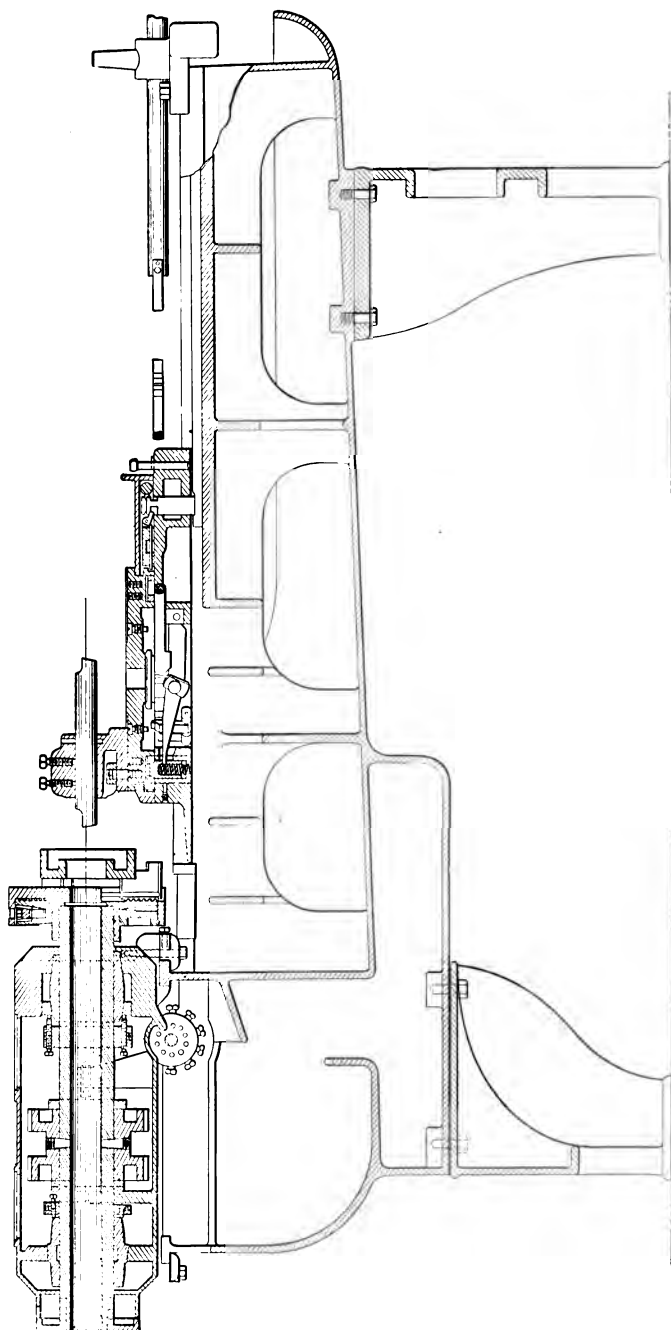


HARTNESS FLAT TURRET LATHE



2 x 24-inch Flat Turret Lathe with Cross-sliding Head — End Elevation









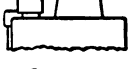
OPERATOR'S SECTION



2 x 24-inch Flat Turret Lathe with Cross-feed Head — Vertical Section







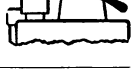

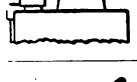
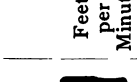
HARTNESS FLAT TURRET LATHE

TABLE OF SPEEDS FOR 3 x 36-INCH FLAT TURRET LATHES

Diagrams Showing Clutch Lever Positions (Speed of Driving Pulley 800 Revolutions per Minute)											
											
											
											
											
											
											
											
											
											
Feet per Minute											
	284	180	118	88	55	36	32	20	13		
Spindle Speeds—(Approximate Revolutions per Minute)											
Screw Thread Cutting		$1\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $2\frac{1}{8}$	$2\frac{1}{8}$ $4\frac{1}{8}$	10 15	
Turning Speeds for Carbon Steel	$\frac{1}{4}$ $1\frac{1}{8}$ $3\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $\frac{1}{2}$ $3\frac{1}{8}$ $\frac{3}{4}$ $\frac{1}{8}$	$\frac{1}{8}$ $1\frac{1}{8}$ 1 $1\frac{1}{8}$ $1\frac{1}{8}$	$\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$ $2\frac{1}{8}$ $2\frac{1}{8}$ $2\frac{1}{8}$	$2\frac{1}{8}$ $3\frac{1}{8}$ $3\frac{1}{8}$ $4\frac{1}{8}$ $4\frac{1}{8}$	$2\frac{1}{8}$ $3\frac{1}{8}$ $3\frac{1}{8}$ $4\frac{1}{8}$ $4\frac{1}{8}$	$2\frac{1}{8}$ 3 $3\frac{1}{8}$ $4\frac{1}{8}$ $4\frac{1}{8}$	$3\frac{1}{8}$ $4\frac{1}{8}$ $5\frac{1}{8}$ $6\frac{1}{8}$ $7\frac{1}{8}$	$5\frac{1}{8}$ $7\frac{1}{8}$ $8\frac{1}{8}$ $10\frac{1}{8}$ $11\frac{1}{8}$	20 25 30 35 40
Turning Speeds for High-speed Steel	$\frac{1}{8}$ $\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$	$\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $2\frac{1}{8}$ $2\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $1\frac{1}{8}$ $2\frac{1}{8}$ $3\frac{1}{8}$ $4\frac{1}{8}$	$1\frac{1}{8}$ $1\frac{1}{8}$ $2\frac{1}{8}$ $3\frac{1}{8}$ $4\frac{1}{8}$ $5\frac{1}{8}$ $5\frac{1}{8}$	$2\frac{1}{8}$ $3\frac{1}{8}$ $4\frac{1}{8}$ $5\frac{1}{8}$ $6\frac{1}{8}$ $7\frac{1}{8}$ $8\frac{1}{8}$	$4\frac{1}{8}$ $4\frac{1}{8}$ $5\frac{1}{8}$ $6\frac{1}{8}$ $8\frac{1}{8}$ $10\frac{1}{8}$ $13\frac{1}{8}$	$4\frac{1}{8}$ $5\frac{1}{8}$ 6 $7\frac{1}{8}$ $9\frac{1}{8}$ $11\frac{1}{8}$ $14\frac{1}{8}$	$4\frac{1}{8}$ $5\frac{1}{8}$ 6 $7\frac{1}{8}$ $9\frac{1}{8}$ $11\frac{1}{8}$ $14\frac{1}{8}$	$7\frac{1}{8}$ $8\frac{1}{8}$ $9\frac{1}{8}$ $11\frac{1}{8}$ $15\frac{1}{8}$ 	$11\frac{1}{8}$ $13\frac{1}{8}$ $14\frac{1}{8}$ $17\frac{1}{8}$ 	40 45 50 60 80 100 125
Turning Feeds	Feeds per Inch	Time Required to Travel One Inch									
		10	.04	.06	.08	.11	.18	.28	.31	.50	.77
		15	.05	.08	.13	.17	.27	.42	.47	.75	1.2
		20	.07	.11	.17	.23	.36	.56	.63	1.0	1.5
		30	.11	.17	.25	.34	.55	.83	.94	1.5	2.3
		45	.16	.25	.38	.51	.82	1.2	1.4	2.3	3.5
		60	.21	.33	.51	.68	1.1	1.7	1.9	3.0	4.6
70	.25	.39	.59	.80	1.3	1.9	2.2	3.5	5.4		
Drilling Feeds	80	.28	.44	.68	.91	1.5	2.2	2.5	4.0	6.2	
	100	.35	.56	.85	1.1	1.8	2.8	3.1	5.0	7.7	

SPEED TABLES

TABLE OF SPEEDS FOR 2 x 24-INCH FLAT TURRET LATHES

Diagrams Showing Clutch Lever Positions (Speed of Driving Pulley 800 Revolutions per Minute)											Feet per Minute
Spindle Speeds—(Approximate Revolutions per Minute)	380	240	160	120	74	50	43	27	18		
Screw Thread Cutting		1/4	1/4	1 1/8 1/2	1 1/8 3/4	3/4 1 1/8	7/8 1 1/8	1 1/8 2 1/8	2 1/8 3 1/8	10 15	
Turning Speeds for Carbon Steel	3/8 1 1/8 1 1/4 1 1/2 1 3/4 2	1/2 3/4 1 1 1/8 1 1/4 1 1/2	1/2 3/4 1 1 1/8 1 1/4 1 1/2	3/8 1/2 1 1 1/8 1 1/4 1 1/2	1 1 1/8 1 1/4 1 1/2 1 3/4 2	1 1/8 1 1/4 1 1/2 1 3/4 2 2 1/4	1 1/8 1 1/4 1 1/2 1 3/4 2 2 1/4	1 1/8 1 1/4 1 1/2 1 3/4 2 2 1/4	2 1/8 3 1/8 4 1/8 5 1/8 6 1/8 7 1/8	20 25 30 35 40	
Turning Speeds for High-speed Steel	3/8 1/2 1/2 1 1/8 1 1/4 1 1/2 1 3/4 2	3/8 1/2 1/2 1 1/8 1 1/4 1 1/2 1 3/4 2	1 1 1/8 1 1/4 1 1/2 1 3/4 2 2 1/4 2 1/2	1 1/8 1 1/4 1 1/2 1 3/4 2 2 1/4 2 1/2 2 3/4	2 1/8 2 1/4 2 1/2 2 3/4 3 3 1/4 3 1/2 3 3/4	3 1/8 3 1/4 3 1/2 3 3/4 4 4 1/4 4 1/2 4 3/4	4 1/8 4 1/4 4 1/2 4 3/4 5 5 1/4 5 1/2 5 3/4	5 1/8 5 1/4 5 1/2 5 3/4 6 6 1/4 6 1/2 6 3/4	8 1/8 9 1/8 10 1/8 11 1/8 12 1/8 13 1/8 14 1/8 15 1/8	40 45 50 60 80 100 125	
Feeds per Inch											
Turning Feeds	.03 .04 .05 .08 .12 .16 .18	.04 .06 .08 .13 .19 .25 .29	.06 .09 .13 .19 .28 .38 .44	.08 .13 .17 .25 .38 .51 .59	.14 .20 .27 .41 .61 .81 .95	.20 .31 .41 .61 .92 1.2 1.4	.23 .35 .47 .70 1.0 1.4 1.6	.37 .56 .74 1.1 1.7 2.2 2.6	.56 .83 1.1 1.7 2.5 3.3 3.9		
Drilling Feeds	.21 .26	.33 .42	.50 .63	.68 .85	1.1 1.4	1.6 2.0	1.9 2.3	3.0 3.7	4.4 5.6		

HARTNESS FLAT TURRET LATHE



View of Our Upper Plant and Springfield Village



Lower Plant where Machines are Assembled

TRAVELING DIRECTIONS FOR VISITORS

Our plants are open to all.

Springfield, Vermont, the home of the Flat Turret Lathe, is located near the Connecticut River just north of Bellows Falls. It is reached by a modern freight and passenger electric railway which connects with the Connecticut River Division of the Boston & Maine Railroad at Charlestown, New Hampshire.

The electric railway cars meet all trains, including the midnight, and take the travelers directly to the office at the Lower Works, which is located on the electric line one and a quarter miles from the terminus.

The Adnabrown Hotel, at the end of the railway, is, of course, ready to receive guests at any hour.

Travelers from Boston come via the Fitchburg Division of the Boston & Maine Railroad through to Bellows Falls, at which junction they change cars to the Connecticut River Division for an eight-mile ride north to Charlestown, where an electric car will be found awaiting the train.

Visitors from New York come to Springfield, Massachusetts, over the New Haven Road, and change there to the Connecticut River trains, which run north through the beautiful Connecticut Valley to Charlestown, New Hampshire. In the summer season White Mountain trains run without change from New York through Charlestown.

The trip takes six to eight hours from New York, and from four to four and one-half hours from Boston.

Travelers from the West, if coming via the New York Central Railroad, generally continue to Springfield, Massachusetts, over the Boston & Albany Division or take the Fitchburg Railroad through the Hoosac Tunnel to Greenfield, Massachusetts, the junction with the Connecticut River Railroad.



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